
The Institute for Advanced Study

Annual Report 1985/86

The Institute for Advanced Study

Annual Report for the Fiscal Year
July 1, 1985-June 30, 1986

The Institute for Advanced Study
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It is fundamental to our purpose, and our express desire, that in the appointments to the staff and faculty, as well as in the admission of workers and students, no account shall be taken, directly or indirectly, of race, religion or sex. We feel strongly that the spirit characteristic of America at its noblest, above all, the pursuit of higher learning, cannot admit of any conditions as to personnel other than those designed to promote the objects for which this institution is established, and particularly with no regard whatever to accidents of race, creed or sex.

Extract from the letter addressed by the Founders to the Institute's Trustees, dated June 6, 1930, Newark, New Jersey.

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The Institute for Advanced Study: Background and Purpose

The Institute takes the following premises on the nature of learning as fundamental: most important work is the product of the disciplined and creative individual mind; accordingly, the individual scholar must be responsible for how he uses the precious resources of his own time and energy; the community of peers in his area of intellectual work is the ultimate judge of the results. (From PROCEDURES FOR ACADEMIC GOVERNANCE OF THE INSTITUTE.)

The Institute for Advanced Study, an independent, private institution devoted to the encouragement, support and patronage of learning, was founded in 1930 as a community of scholars where intellectual inquiry could be carried out in the most favorable circumstances. Focused on mathematics and classical studies at the outset, the Institute today consists of the School of Historical Studies, the School of Mathematics, the School of Natural Sciences and the School of Social Science. Each School has a small permanent Faculty, and some 160 fellowships are awarded annually to Visiting Members from other research institutions and universities throughout the world.

The objectives of the Institute were described as follows in the Founders' original letter to the first Trustees: "The primary purpose is the pursuit of advanced learning and exploration in the fields of pure science and high scholarship to the utmost degree that the facilities of the institution and the ability of the faculty and students will permit." During the past half-century, these goals have been implemented by a Faculty of exceptional merit; by an annually renewed group of Visiting Members chosen from among the many who apply; and by the development of facilities and a mode of operation designed specif-

ically to support and assist the Institute's intellectual purposes in every way possible.

Although the Institute is small when measured in terms of the size of its immediate academic community or of its operating budget, its intellectual weight is great and its influence on science and scholarship extraordinary. From its earliest years, it has been internationally recognized as one of the world's leading centers of research. Indeed, its successful example has created numerous imitators both in the United States and abroad.

From the beginning, the Institute has been an international organization, although American in location and organizational form. It has operated throughout its existence on the premise that science and learning transcend national boundaries and that scholars and scientists are members of one commonwealth of the mind. Of the present Faculty, many have begun their scientific and scholarly careers outside the United States. One-third of the Visiting Members come from abroad, mostly from the great centers of learning of western Europe and Asia, and, to a lesser extent, from other regions of the world.

With its devotion to the continuing examination of new and centrally important questions as they arise at the frontiers of knowledge, the Institute partakes of the character of both a university and a research institute, but it also differs in significant ways from both. Unlike a university in its small size—its academic membership at any time numbers about 200—it has no commitment that all branches of learning be represented in its Faculty and Members. Unlike the usual research institute, it supports many different fields of study, maintains no laboratories, and above all, welcomes temporary members whose intellectual development and growth are one of

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its principal purposes. But it shares with both universities and research institutes a devotion to learning, in the double sense of the continuing education of the individual and of the intellectual enterprise on which the member is embarked.

For more than five decades the Institute for Advanced Study has made a substantial contribution to the world of higher learning by providing support—intellectual and material—to Visiting Members whose development and growth constitute one of its principal purposes. More than one third of these Visiting Members are young men and women 35 years of age or less whose work at the Institute involves the Faculty in a substantial amount of postdoctoral training. Though none of the Visiting Members is a student in the narrow sense of being a degree candidate, the communal atmosphere and many opportunities for discussion with Faculty members and peers, both within and outside seminar meetings, are propitious to scholarly growth.

The Institute devotes special attention to young people of accomplishment and promise, offering them membership at a stage in their careers when independent work is of the highest importance to their intellectual development. These younger Members then return to or join the faculties of universities all over the world and share what they have learned as a result of their stay at the Institute. This might be termed the invisible work of the Institute; its visible work is contained in the publications of the Faculty and Visiting Members. Both serve to reinforce in highly significant ways the quality of scholarship and research throughout the world.

The varied work of the Institute is, of course, specialized; no advanced study or deep scholarship can be otherwise. Formal attempts to organize scholarly work at the Institute are minimized, although lectures and seminars are a regular feature of its internal life. Schools may, for limited periods of time, select certain themes or programmatic arrays under which Members are encouraged to apply, but no concentration guarantees entry

and no focus excludes those outside it. The choice and conduct of research are matters which are decided entirely by each individual member of the Institute.

The Institute is nonetheless an intellectual community and not a mere collection of scholars. Community is possible because Faculty and Members have some substantial knowledge outside their own fields of specialization. The fact that the Visiting Members live together in Institute housing, eat in the same dining hall, share the same common room and libraries, and carry out their work in an institutional setting where human scale has been carefully maintained is conducive to common interest, mutual understanding and friendship.

The Faculty and Members of the Institute are also a part of the larger community of Princeton, with its University and its many institutions of research and learning. Although the Institute has no administrative or organic connection with Princeton University, there has always been close collaboration between the two institutions on matters of common interest. Many Institute seminars are open to interested members of the University's faculty and graduate school, and University seminars and conferences are frequently attended by Institute Faculty and Members. Without the University, Princeton itself would be both physically and intellectually inadequate as the site of the Institute; and the Institute has brought a degree of international excellence to the general academic climate of Princeton, contributing to the development of what has become one of the world's great educational communities.

The Institute today occupies a square mile of land in Princeton, New Jersey. Most of this is farm and woodland. Its buildings house libraries, offices for Faculty and Members, seminar and lecture rooms, and common rooms. Subsidized, conveniently located housing is maintained for all Visiting Members, and transportation is regularly provided to the center of town.

Report of the Chairman

As announced in my annual report of 1984-85, a Planning and Review Committee was set up in the spring of 1984 to review the objectives, structure, operation, and intellectual direction of the Institute, and to consider its future, as had been done by previous committees in 1956, 1965, and 1976. James D. Wolfensohn, President of the Corporation and Vice-Chairman of the Board, agreed to chair this Committee whose other members were George B. Field (until his resignation from the Board in 1985), Michael V. Forrestal, Martin E. Segal, Donald B. Straus, and me *ex officio*. Donna Manning served as its executive secretary.

Over a two-year period, the Wolfensohn Committee has been at work, meeting with the Director and Faculty, interviewing by means of a questionnaire former Visiting Members, inviting the comments of distinguished outside scholars and looking at comparable institutions.

A preliminary report was prepared for the Board of Trustees' meeting in April, 1986, a summary of which follows.

The Committee began by reaffirming the original purpose and objectives of the Institute. The Institute's aim is "the pursuit of advanced learning in the various fields of human knowledge." It should be staffed by "men and women of the highest standing in their respective fields of learning." It should provide "an intellectual and physical milieu that stimulates the research and scholarship of its Faculty and Visiting Members, and, through its choice of and influence on Visiting Members, [play] an important role in the intellectual formation of a significant number of the ablest scholars in the fields in which it is active." The Committee also accepted the original premise of independent activity agreeing that "most important work is the

product of the disciplined and creative individual mind; accordingly, the individual scholar must be responsible for how he uses the precious resources of his own time and energy; the community of peers in his area of intellectual work is the ultimate judge of the results."

The Committee identified a number of key elements in the continuity of these aims, among which were: men and women of high scholarship; flexibility in the selection of areas of study and a responsiveness to change; the dual purpose of the Faculty's own scholarship and their encouragement and support of Visiting Members; the freedom of individual pursuit; and judgment by peers. The Committee also reaffirmed its commitment to reward the Faculty at a level consonant with their high quality and their commitment to the Institute.

The Committee's preliminary report sought to evaluate the present state of each of the above elements as well as to focus on the financial status of the Institute (budget, fund-raising, financing), its governance, and the appointment of a successor to the present Director. Particular attention was given to the matter of how to assess the individual Schools so as to maintain high scholarly quality; how to address the issue of exploring new scholarly directions; how to raise Member stipends; and how to define more clearly, in some Schools, the optimum relation between permanent and visiting members. These matters will continue to be discussed at the Board, administrative, and Faculty levels.

At the same April Board meeting, my resignation as Trustee and Chairman of the Board became effective and the Board elected James D. Wolfensohn to be my successor. Mr. Wolfensohn has served the Institute as a member of the Board since 1979 and as Presi-

dent of the Corporation and Vice-Chairman of the Board since 1983. He is president of James D. Wolfensohn, Inc., an advisory and investment firm established in New York in October 1981. Born in Australia, Mr. Wolfensohn holds B.A. and LL.B. degrees from the University of Sydney and an M.B.A. degree from the Harvard Graduate School of Business. He served as a Royal Australian Air Force Flying Officer, and in 1956 was a member of the Australian Olympic Fencing Team. His public interest and volunteer efforts include his work as Chairman of the Board of Carnegie Hall Corporation and as Trustee of the International Federation of Multiple Sclerosis Societies, The Brookings Institution, Rockefeller University, the Joint Center for Political Studies, and the Joseph H. Lauder Institute of Management and International Studies. He is an Advisory Director of the Metropolitan Opera Association and of the International Center in New York. He is also a member of numerous corporate boards.

Charles L. Brown was elected Vice-Chairman of the Board of Trustees. Mr. Brown has been a Trustee of the Institute since 1979. He was Chairman of the Board and Chief Executive Officer of AT&T (until September 1, 1986), having joined that company in 1946, and served it in various capacities in a number of cities. He became President of AT&T in 1977 and Chairman of the Board in 1979. Mr. Brown is a graduate of the University of Virginia, with a degree in electrical engineering, and saw active duty in the U.S. Navy in the Second World War. Mr. Brown is a former Director of AT&T and is a current director of du Pont, Chemical Bank, Delta Airlines, Metropolitan Life Insurance Company, and Ryder System. He is Chairman of the Board of the Colonial Williamsburg Foundation, and a Trustee of Columbia Presbyterian Hospital

and the Aspen Institute. He was Vice-Chairman of the Corporate Fund for the John F. Kennedy Center for the Performing Arts and has helped organize support for a number of other civic and charitable organizations, having also served as Trustee of the University of Chicago, and as Vice-Chairman of the Lake Forest College Board of Trustees. He is currently a member of the Board of Visitors (Trustee) of the University of Virginia.

A Trustee Search Committee under the chairmanship of Thornton Bradshaw has been established to seek a new Director, since Dr. Harry Woolf will resign at the end of the 1986-87 academic year. Its other members are Daniel Bell, Zeph Stewart, Donald Straus, James D. Wolfensohn, and, representing the Faculty, Professors John Bahcall, Giles Constable, Robert Langlands and Michael Walzer.

Professor T. D. Lee was elected to the Board during the winter to replace George Field who had to resign for reasons of health. Professor Lee is a professor of physics at Columbia University. He was born and educated in China and has a doctorate from the University of Chicago. He was formerly a Visiting Member at the Institute for Advanced Study in 1951-53 and 1957-58 and a Faculty member in the School of Natural Sciences from 1960-62. In 1957 he received the Nobel prize in physics together with Chen Ning Yang.

It has been a rare privilege to have served an institution as intellectually important and interesting as the Institute for Advanced Study. I leave it as I found it: a strong and lively center for learned investigation and scholarly discourse. Such centers of scholarship are even more essential than ever before, more to be valued, more to be sustained.

J. Richardson Dilworth
Chairman

Report of the Director

At the April meeting of the Board of Trustees, J. Richardson Dilworth resigned as Chairman of the Board and as active Trustee of the Institute. His devotion to this institution has been marked since he first became a member of its Board in 1964, and it has been my good fortune to work with him first as President of the Corporation and Vice-Chairman of the Board, a position he occupied since 1970, six years prior to my arrival, and as Chairman since 1981. His work on behalf of other fine institutions such as Yale University, the Metropolitan Museum of Art, and Rockefeller University was matched by his careful attention to large and small matters here and by his unfailing energy, good humor, and firm guidance in these past five years. At a luncheon in his honor, the Board of Trustees presented him with the following testimonial:

"To our colleague, J. Richardson Dilworth, dedicated amateur of British maritime history, valiant navigator not only in the waters of the past but on many a present sea, a Trustee from 1964 to 1986, who has led the Institute in these last five years as Chairman of its Board of Trustees, and before that as its President and Vice-Chairman, his fellow Trustees and the Institute community herein offer their heartfelt thanks for his countless services to this institution. He has shared in the Institute's every concern, sat on its every committee, responded generously to its every need, and in so doing, has, with imagination and diplomacy, helped to secure its substance and honor its purposes. Friend to the entire enterprise, he cheerfully brought his energies and abilities to the support of learning and excellence as it is practiced here, and his voice will be missed in our counsels. We wish him godspeed in his retirement and express here-with our deep gratitude for all that he accomplished with us and for us during the many years of the Trusteeship he so ably exercised."

This year completes the tenth year of my Directorship of the Institute and so provides a good moment to reflect on some of the processes which have occurred over the past decade. Since next year's report will be my last as Director, I will defer until then a review of the several developments and changes which have taken place during my tenure, and concern myself here with one of the more significant innovations during this time, that of the visiting committees to the four Schools.

Visiting Committees

Ten years ago, as part of the recommendations of the Review Committee referred to in the report of the Chairman, a periodic examination of the four Schools which make up the Institute was advised. The School of Natural Sciences was the first School to be visited by a committee in 1980; the School of Historical Studies in 1982-83; the School of Social Science in 1984; and the School of Mathematics this past year, in 1985-86. In each case a similar procedure was followed. A list of names of distinguished colleagues was prepared by the School to be visited. From this list, four or five men and women were invited by the Director in consultation with the appropriate academic Trustee to serve on the visiting committee, under the Trustee's chairmanship. For a period of two days, the visiting committee met with the Director, with members of the Faculty, and with the Visiting Members. At a later time, the Committee either reassembled in person or consulted together by telephone to review, record, and refine their impressions. Their recommendations were submitted in a report to the Director of the Institute, who in turn shared the report with the Faculty

of the visited School and the members of the Board of Trustees.

What have these visiting committees accomplished? While assessments might vary, let me suggest here a number of positive results. The most important achievement, I think, is that the principle of accountability has been strengthened. To be sure, our Procedures for Academic Governance which date from 1974 state that it is up to each individual how he uses the precious resources of his time here. But at a certain point any segment of a community, even—and perhaps especially—one so free and fortunate as ours, must be able to show that it is fulfilling its commitment to that community. If the purpose of a School is to encourage the highest forms of research of its permanent and temporary members, then, occasionally, it must indeed demonstrate that its goal is being achieved.

Beyond the assertion of that principle of accountability, there is for the Schools the useful exercise of being required to arrive at some description or statement of their mode of operation, their concerns, their needs, as well as their accomplishments. It is a chance for the divergent views within a School—always a sign of healthy intellect—to find a hearing. It is a chance for the Visiting Members to express their own opinions. The visiting committees have in every case included recommendations in their reports which have led to interesting debate and subsequent action. Finally, after due consideration of the entire process, the Faculty judged the work of such committees to be beneficial and offered suggestions for their continuation and future use.

Whether this system of evaluation remains in place or yields to another type or model, its existence is critical to the maintenance of the high standards of this institution. We are grateful to those scholars who have served on our visiting committees and given so generously of their time and energies to help us toward the better definition of our purposes and the fuller realization of our aims.

The visiting committee to the School of Mathematics which met here last winter was

composed of Professor James Glimm, Courant Institute of Mathematical Sciences; Professor Calvin Moore, Associate Vice-President for Academic Affairs, University of California at Berkeley; Professor G. Daniel Mostow (Chairman), Yale University; Professor David Mumford, Harvard University, and Professor Elias Stein, Princeton University. Their report began with the recognition that

"from its inception, the Institute for Advanced Study has played a unique role in raising the level of mathematics research in American universities to the preeminent level which it has attained in our times. The School of Mathematics continues to play a vital role of worldwide leadership in bringing together the best mathematicians of the world, thereby enhancing the quality of mathematicians of not only our country but of countries throughout the world. Virtually every United States mathematician active in research has spent extended periods of time at the Institute. These stays have had a profound influence on the development of their careers. Other institutes established in the United States and around the world have taken the School of Mathematics as their model. It is a jewel in the crown of the Institute."

"The preservation of its unique role throughout an era in which the mathematical sciences are expanding and diversifying rapidly poses a formidable challenge to the School of Mathematics, which is virtually constrained not to increase its size. The challenge is compounded by the creation of new research institutes and new NSF post-doctoral programs. The question of how well that challenge is being met has been implicit throughout the many exchanges of views that we have had with Faculty and Visiting Members."

The report continued with an examination of the Faculty and their fields, the visiting membership program, the facilities, an analysis of the current needs of the School, the School's relation to government agencies and depart-

ments, and financial considerations. These comments and recommendations are currently under discussion in the School and so provide a good working base for the decisions to be made for the future.

New Faculty

As of next fall, three new professors will have joined the Faculty. Peter Paret comes to the School of Historical Studies from Stanford University where he held the Raymond A. Spruance Chair of International History. He has published numerous books on modern European civilization, and has recently served as principal editor of the new edition of *Makers of Modern Strategy*, a work first published by the Institute in 1943 and edited by Edward Mead Earle, Professor in what was then the School of Economics and Politics. At the Institute, Professor Paret will hold the Andrew W. Mellon Chair in the Humanities.

In the School of Mathematics, Luis A. Caffarelli and Thomas C. Spencer have been appointed to the Faculty. Professor Caffarelli comes to the Institute from the University of Chicago and has held previous academic positions at the University of Minnesota and the Courant Institute of Mathematical Sciences at New York University. His principal field is partial differential equations. Professor Spencer is a mathematical physicist who was on the faculty of the Courant Institute prior to his appointment here. He has also taught at Rutgers University and Rockefeller University.

Members' Program

Visiting Members to the four Schools are chosen on the basis of open competition and selected by the Faculty of each School. The total number of Members this year was 143. Of these, 39% were under the age of 35, and 11% were women. Members in 1985-86 came from 91 institutions located in 19 countries. The names, academic backgrounds, and fields of

interest of this year's Members and Visitors are described in the pages which follow.

Among the many individuals of note who have been part of our community this year, special mention should be made of the Director's Visitor, Joseph Frank, Professor of Comparative Literature at Princeton University. Professor Frank has been working on a multi-volume biography of Dostoevsky, two volumes of which have already appeared, the first volume having won both the James Russell Lowell Prize and the Christian Gauss Award and the second volume having earned the National Book Critics' Circle Award.

AMIAS

This year, for the first time, the Association of Members of the Institute for Advanced Study combined the mailing of their newsletter and their request for funds to support Visiting Members with the letter issued by the Director's Office toward that same purpose. At the same time, the dues for AMIAS membership were waived, so that from this year forward, all former Visiting Members are automatically members of AMIAS. We are very grateful to AMIAS members whose contributions over the past ten years have now amounted to a fund of more than \$81,000. As this fund increases, it will eventually make possible the presence here of a Visiting Member funded by the Association itself.

In the spring, the fifth biennial AMIAS conference was held at the Institute. Speakers included Professor Joan Scott from the School of Social Science and former Visiting Members Jeremy Bernstein and Murray Gerstenhaber.

Other Events

As in the past, a number of workshops and symposia were held at the Institute during the year. Among these were a Symposium on the Structure and Dynamics of Elliptical Galaxies, sponsored by the International Astronomical Union and organized by two Long-term Members in the School of Natural Sciences,

Tim de Zeeuw and Stefano Casertano; a Stellar Dynamics Workshop, organized by Professor Piet Hut of the School of Natural Sciences; and a conference on Women in Twentieth-Century American Politics, organized by Professor Joan Scott of the School of Social Science. Less academic in nature but also of importance to the life of the community were the social events of the various seasons, and, for the first time this year, a series of movies shown in the dining hall. As in previous years, the Institute facilities were made available selectively to a few eleemosynary organizations.

Funding

To meet its own budget, the Institute leans heavily on the generosity of Foundations, both government and private, on gifts from corporations, Trustees, friends and alumni. The larger donors are listed at the end of the Annual Report, but I wish to take this opportunity to thank all those who have helped to support us, with whom we share a common commitment to the pursuit of knowledge and the value of free and independent research.

Harry Woolf
Director

Reports of the Schools

The School of Historical Studies

Faculty

Glen W. Bowersock
Marshall Clagett
Giles Constable
John H. Elliott

Christian Habicht
Irving Lavin
Morton White

Professors Emeriti

Harold F. Cherniss
Felix Gilbert
James F. Gilliam
George F. Kennan

Benjamin D. Meritt
Kenneth M. Setton
Homer A. Thompson

Members with Long-term Appointments

Bernard Lewis

Otto E. Neugebauer

The School of Historical Studies

The School of Historical Studies is concerned principally with the history of western civilization. Within this wide area of study, a large range of topics has been explored at one time or another both by current and emeriti Faculty and by Visiting Members, but the emphasis has been particularly strong in the fields of Greek and Roman civilization, medieval and modern European history, and the history of art, science and ideas.

The particular emphases of the School are a product of its own history. Two years after the opening of the School of Mathematics in 1933, a School of Economics and Politics and a School of Humanistic Studies were established. In Humanistic Studies, the first professor was Benjamin Dean Meritt, a specialist in Greek history and epigraphy, who was closely associated with excavations in the Athenian Agora. The second appointment to the Faculty of the School of Humanistic Studies was that of the renowned German art historian, Erwin Panofsky. Panofsky ranged through the entire gamut of European art from the middle ages to motion pictures, but he was particularly associated with the development of the field of iconology.

Three additional appointments strengthened the field of classical studies: Elias Avery Lowe, a Latin paleographer who was embarked on the prodigious task of assembling, transcribing, documenting, photographing, and publishing all the extant Latin literary manuscripts copied before the ninth century; Ernst Herzfeld, a Near Eastern archaeologist and historian, whose scholarly work, by the time of his death, comprised nearly 200 titles; and Hetty Goldman, one of the pioneering American women involved in archaeology whose discoveries at Tarsus in Turkey were

published in six volumes. Modern history was represented at the Institute from the outset, with the appointment of the military historian Edward M. Earle. Earle was an original member of the School of Economics and Politics, which merged in 1949 with the School of Humanistic Studies to become the School of Historical Studies.

After World War II, classical studies were further augmented by the appointments of Homer A. Thompson in Greek archaeology, Harold F. Cherniss in Greek philosophy, and Andrew Alföldi in ancient history and numismatics. Although Alföldi published tirelessly on a wide range of subjects during his years at the Institute, he was mainly preoccupied with the history of Early Rome and that of Julius Caesar, on both of which subjects he wrote several books. Medieval history came to the Institute Faculty with Ernst Kantorowicz, whose interests stretched in time from the later phases of classical antiquity to the fifteenth and sixteenth centuries, and in space embraced both western Europe and the Byzantine and Islamic East. The art historical tradition was carried on by Millard Meiss, who was able to complete at the Institute his great work on late medieval manuscript painting in Burgundy.

Additions to the Faculty in modern history came with the appointments of Sir Ernest Llewelyn Woodward in British diplomatic history; George F. Kennan, former Ambassador to Russia, in Russian history and international relations; and Felix Gilbert, in Renaissance as well as modern history. Roman military history and papyrology were represented by James F. Gilliam; medieval history of the Latin East, Venice, and the relations between the Papacy and the Levant, by Kenneth

M. Setton; medieval science, especially the classical heritage, by Marshall Clagett.

While these traditions have remained strong in the School of Historical Studies, they have not excluded scholars working in other fields who have come here as Visiting Members. The total number of Visiting Members who have come to the School is now more than a thousand. The articles and books resulting from their research at the Institute are witness to the quality and productivity of their scholarly activity here.

Academic Activities, 1985-86

The School was host to forty-one long-term, term and annual Members in 1985-86 and nine Visitors. During the summer of 1985, it also provided research facilities for seven summer Visitors. Twenty-one Members came from foreign countries, including Bulgaria, Canada, England, France, Hungary, Italy, Poland, and West Germany.

All Members and Visitors at the Institute are independent scholars and concentrate on their own subjects. The topics of their individual projects are listed in the next section. But contacts and exchanges with one another, whether organized or informal, are often fruitful and stimulating. Among the formal colloquia—lectures followed by discussions—were those in art history on a monthly basis in which Princeton University's department took part. Some of the Members also gave papers at meetings of the Institute's School of Social Science. All these are listed in the Record of Events.

Faculty

Professor Glen Bowersock participated in colloquia at Bad Homburg (West Germany), Valbonne (France), and Petra (Jordan). His contributions presented preliminary research on a new project concerning the relation of Hellenism to the survival of local culture in the Roman and early Byzantine Near East. He also lectured at Dumbarton Oaks, The Johns Hopkins University, Loyola College (Balti-

more), and Ball State University (Indiana). Over the year he published a dozen articles and continued his service as a Senior Fellow at Dumbarton Oaks and at the Center for Hellenic Studies, as a Member of the Council of the American Numismatic Society, and as a Trustee of the American Schools of Oriental Research. He accepted the general editorship of a new series on classical studies to be published by the Harvard University Press.

Professor Giles Constable gave lectures at the University of Edinburgh and the Institutionele Geschiedenis der Middeleeuwen, Ghent, Belgium, and presented papers to the forgeries meeting at Columbia University, the Medieval Academy of America meeting in Albuquerque, the Princeton Theological Seminary Church History Seminar, and the linguistic pluralism meeting in Montreal, and he presided at a meeting of the Delaware Valley Medieval Association. A number of his articles appeared, including "Suger's Monastic Administration" in *Abbot Suger and Saint-Denis*, published by the Metropolitan Museum of Art, as well as book reviews in *Speculum*, *The Journal of Ecclesiastical History*, and *Manuscripta*. He prepared lectures on the imitation of Christ and papers on forged letters in the Middle Ages and history and historiography in the eleventh and twelfth centuries.

Professor John Elliott was given the Leo Gershoy Award of the American Historical Association for his book, *Richelieu and Olivares*, and gave a talk at the Association's annual meeting in December 1985. He worked on proofs of his forthcoming book, *The Count-Duke of Olivares*, and gave lectures around the country, including one in Washington, D.C. and one in California. He also gave a lecture at a conference held in Paris in November 1985 to celebrate the fourth centenary of the birth of Cardinal Richelieu.

Professor Christian Habicht had his Sather Lectures published by the University of California Press under the title *Pausanias' Guide to Ancient Greece* and in a German edition by C. H. Beck (*Pausanias und seine Beschreibung Griechenlands*). He published several papers and wrote another on Athens and the Delphic

Amphictiony in the early second century B.C., to appear in *Hesperia*. He read proofs of an edition of numerous unpublished inscriptions from Thessaly. He also prepared the Semple Lectures, to be given in the spring of 1987 at Cincinnati. He was invited to deliver the first Fordyce Mitchel Memorial Lecture at the University of Missouri, Columbia.

Professor Irving Lavin delivered the Jerome Lectures at the University of Michigan and at the American Academy in Rome. He gave individual lectures at various American institutions, and in Paris, Munich, Milan and Florence. At the 26th International Congress of the History of Art, he was elected President of the Comité International d'Histoire de l'Art. He was also elected Foreign Member of the Accademia Nazionale dei Lincei, Rome, and of the Accademia Clementina, Bologna. He was the editor of a volume of essays, *Gianlorenzo Bernini: New Aspects of his Art and Thought*, published by the College Art Association of America.

Professor Morton White held an appointment in the summer of 1985 as Visiting Scholar in Philosophy at Harvard University. He and his wife, Lucia White, published their book *Journeys to the Japanese, 1952-1979*. Professor White read proofs of his Neesima Lectures at Doshisha University in Kyoto; they will be published under the title *Pragmatism and the Politics of Epistemology*. He also read proofs of his forthcoming book *Philosophy, The Federalist, and the Constitution*.

Professors Emeriti

Professor Harold F. Cherniss pursued his studies of ancient Greek philosophy and especially of Aristotle's criticism of Plato and the Academy.

Professor Marshall Clagett completed the first volume of his *Ancient Egyptian Science: A Source Book*. This volume bears the subtitle: *Knowledge and Order*. In the course of preparing this volume Professor Clagett designed computer fonts to depict hieroglyphs and their phonetic representation.

Professor Felix Gilbert presented a paper on

"Ranke and the American Philosophical Society" at the 1985 fall meeting of the American Philosophical Society, and he gave a seminar on "The Development of Nineteenth-Century Historiography" at Stanford University in March 1986. He was Chairman of the session on Historiography at the International Historical Congress in Stuttgart in August 1985. The revised edition of *Makers of Modern Strategy*, of which Professor Gilbert is an Associate Editor, and to which he contributed two chapters, was published early in 1986. He continued to do research on nineteenth-century historiography and in the context of these researches he published a study, "Jacob Burckhardt's Student Years; The Road to Cultural History" in the *Journal of the History of Ideas*. He published reviews in the *American Historical Review*, the *Journal of Modern History*, and the *Renaissance Quarterly*.

Professor James F. Gilliam's book, *Roman Army Papers* (MAVORS II), was published. He also completed an addenda to the bibliography of M. I. Rostovtzeff, to be published in *Historia*.

Professor George F. Kennan continued his research on the third volume in a series on the Franco-Russian Alliance of 1894. He published an article on "Morality and Foreign Policy," in *Foreign Affairs*. Professor Kennan was honored at a symposium on "Containment and the Future," sponsored by the National Defense University in cooperation with the Foreign Service Institute, in November 1985. He delivered the Blashfield Address on the subject of "History and Literature" at the Annual Ceremonial of the American Academy and the Institute of Arts and Letters in May 1986, and received honorary doctorates from Columbia University, The College of William and Mary, and the University of Helsinki. He also received the Brandeis University Creative Arts Award for Non-Fiction in May 1986.

Professor Kenneth M. Setton was elected a Foreign Member (*Socio Straniero*) of the Ateneo Veneto in February 1986. He gave a lecture at the joint meeting of the American Philosophical Society and the Royal Society in Philadelphia in April 1986, and continues to

work on a book on *Venice and the Turks in the Seventeenth Century*.

Professor Homer Thompson continued to supervise the editing of the results of excavation of the Athenian Agora. Three additional volumes are currently in press: *Red Figure Pottery, An Assemblage of Marble Inscriptions, Athens in Late Antiquity*. The month of June, 1986, was spent in Athens for the study of material from the Agora. In September of 1985, after visiting a number of archaeological sites in Syria and Jordan, he took part in a symposium at Petra on "Petra and the Caravan Cities." In May, 1986, he received an honorary degree from Queen's University, Kingston, Ontario.

Long-term Members and Visitors

Professor Bernard Lewis lectured at Cornell University as the A. D. White Professor at

Large. He delivered the Anwar Sadat Memorial Peace Lecture on "Religion and Politics in the Middle East" to Union College in Schenectady, New York. He also lectured at the National Defense University in Washington, D.C., Colorado State University, and the Foreign Policy Association. He attended conferences and meetings in West Berlin, Pecs (Hungary), and Ankara, and received the American Friends of Turkey Award in Washington, D.C. His book, *Semites and anti-Semites*, was published by W. W. Norton in May, 1986. French, German and Hebrew translations are in preparation. Gallimard published his collected essays in French translation under the title *Le Retour de l'Islam* in 1985.

Professor Otto E. Neugebauer completed a manuscript on the "Chronography" of Abu Shaker, accepted for publication by the Vienna Academy. He continued his investigations of Ethiopic chronological tables.

The School of Historical Studies

Members with Long-term Appointments, Members, Visitors and Assistants 1985-86

In the section which follows, the information was obtained from material provided by the Members, Visitors and Assistants.

Members with Long-term Appointments

Bernard Lewis, see page 65 for biographical information.

Otto E. Neugebauer, *History of exact sciences in antiquity and Middle Ages*.

Born 1899, Innsbruck, Austria. University of Göttingen, PhD 1926; University of St. Andrews, LLD 1938; honorary doctorate Brown University, Princeton University.

University of Göttingen, assistant professor 1927-33; founder and joint editor of *Quellen und Studien zur Geschichte der Mathematik, Astronomie, und Physik* 1930-38; University of Copenhagen, research professor 1933-39; University of Cambridge, W. Rouse Ball Lecturer 1939; Cornell University, Messenger Lecturer 1949; Brown University, professor of the history of mathematics and professor emeritus 1939-69; Institute for Advanced Study, School of Historical Studies, member 1950-55, 1959-60, member with long-term appointment 1960- ., School of Natural Sciences, member 1950, 1952, 1954, 1956, 1958, member with long-term appointment, 1960- .

Members

Graziano Arrighetti, *Ancient Greek literary criticism*.

Born 1928, Florence, Italy. Scuola Normale Superiore, University of Pisa, Dottore in Lettere 1951.

University of Pisa, Lib. Doc. 1959, Prof. Ord. 1969- .

Peter John Bakewell, *The life of Don Francisco de Toledo, fifth viceroy of Peru*.

Born 1943, Oldham, England. University of Cambridge, BA 1965, MA 1968, PhD 1969.

Trinity College, University of Cambridge, junior research fellow 1968-72; University of New Mexico, assistant professor 1975-76, associate professor 1976-85, professor 1985- .

Jean Beaujeu, *Cultes à mystères dans l'Empire romain*.

Born 1916, Cherbourg, France. University of Paris IV (Sorbonne), licence lettres class. 1939, doctorat ès lettres 1953.

Centre National de la Recherche Scientifique, attaché 1943-47; University of Lille, chargé d'enseignement 1948-54, professeur 1954-64; University of Paris-Nanterre, professeur 1964-71; University of Paris IV (Sorbonne), professeur 1971-84.

Jean-Claude Boyer, *The painting of Pierre Mignard*.

Born 1946, Arthés (Tarn), France. University of Toulouse, licence de lettres 1968, licence d'histoire de l'art 1969; agrégation des lettres 1973.

University of Nancy, chargé de cours 1974-75; Centre National de la Recherche Scientifique, attaché de recherche 1976-78, 1980-82, chargé de recherche 1982- ; University of Paris IV (Sorbonne), chargé de cours 1976-78, 1980-85.

Adriano Carugo, *History of mathematics and natural philosophy in the sixteenth and seventeenth centuries*.

Born 1936, S. Vittore, Milan, Italy. University of Milan, PhD 1959.

University of Milan, assistant professor 1959-64, professor 1969-71; University of Oxford, British council scholar 1964-67; University of Venice, professor 1971- .

Christian A. D. Derouet, *History of art*.

Born 1945, La Jaille-Yvon, France. Université de Rennes, MA 1968.

Conservateur des Musées Nationaux 1969; Musée National d'Art Moderne, curator 1974- ; Museum of Modern Art, researcher 1977; Société Kandinsky, secretary 1979- .

Jehan Desanges, *A commentary on Strabo's Geography XVIIth book (concerning Africa).*

Born 1929, Nantes, France. Agrégation 1953; University of Paris IV (Sorbonne), Doctorat d'Etat 1976.

Colleges of Algeria and Tunisia, professeur de lycée 1952-59; Université de Dakar (Sénégal), maître assistant 1959-63; Université d'Alger, maître de conférences 1963-64; Université de Nantes, maître de conférences, professeur 1964-83; Ecole Pratique des Hautes Etudes, Sorbonne, Paris, professeur 1983- .

Jenö Fitz, *Roman prosopography; history of the Danubian provinces.*

Born 1921, Budapest, Hungary. University of Budapest, PhD 1947; Hungarian Academy, DSc 1985.

University of Budapest, assistant lecturer 1947-49; Istvan Kiraly Muzeum Székesfehérvár, director 1949-85; Museums of County Fejér, director 1962-85; *Alba Regio*, editor 1961- ; Hungarian Archaeological and History of Art Society, president 1984- .

Dagfinn Follesdal, *Husserl's Phenomenology.*

Born 1932, Askim, Norway. University of Oslo, MA 1956; Harvard University, PhD 1961.

Harvard University, instructor/assistant 1961-64; University of Oslo, professor 1967- ; Stanford University, professor 1968- .

Robert Fox, *Science and technology in nineteenth-century France.*

Born 1938, Bradford, England. University of Oxford, BA 1961, MA 1965, DPhil 1967.

Institute for Advanced Study, member 1974-75; University of Lancaster, lecturer 1966-72, senior lecturer 1972-75, reader 1975- ; Princeton University, visiting professor 1979; British Academy, reader 1983-86.

David Hodes Friedman, *Florentine town foundation, 1299-1350.*

Born 1943, Allentown, Pennsylvania. Brandeis University, BA 1966; Harvard University, PhD 1972.

University of Pennsylvania, assistant professor 1972-78; Massachusetts Institute of Technology, assistant professor 1978-81, associate professor 1981- .

Emilio Gabba, *The influence of classical antiquity on the political thought of John Adams.*

Born 1927, Pavia, Italy. Università di Pavia, laurea in lettere 1948, libero docente in storia romana 1955.

Università di Pavia, assistente 1952-58, professore ordinario 1974- ; University of Pisa, professore ordinario 1958-74; University of Pennsylvania, visiting professor 1969; University of Oxford, visiting professor 1971; Institute for Advanced Study, member 1973; University of California at Berkeley, professor 1980.

Daniel Elliot Garber, *Metaphysics and physics in Descartes.*

Born 1949, Schenectady, New York. Harvard University, BA 1971, MA 1974, PhD 1975.

University of Chicago, assistant professor 1975-82, associate professor 1982- ; University of Minnesota, visiting assistant professor 1979; The Johns Hopkins University, visiting assistant professor 1980-81; Princeton University, visiting associate professor 1982-83.

Carlo Ginzburg, *The origins of the witches' sabbath.*

Born 1939, Turin, Italy. University of Pisa, laurea 1961, libera docenza 1968.

University of Bologna, professore incaricato 1970-76, professore ordinario 1978- ; University of Lecce, professore ordinario 1976-78; Institute for Advanced Study, member fall 1975; Yale University, visiting professor 1984.

Jack Phillip Greene, *Corporate identity in British America during the early modern era.*

Born 1931, Lafayette, Indiana. University of North Carolina, BA 1951; Indiana University, MA 1952; Duke University, PhD 1956.

Michigan State University, instructor 1956-59; Western Reserve University, assistant professor 1959-62, associate professor 1962-65; College of William and Mary, visiting associate professor 1961-62; The Johns Hopkins University, professor 1966- ; Institute for Advanced Study, member 1970-71; Columbia University, visiting professor 1973-74, 1978; University of Oxford, professor 1975-76.

David Drisko Hall, *Popular religion in seventeenth-century New England.*

Born 1936, Washington, D.C. Harvard College, BA 1958; Yale University, PhD 1964, Yale University, assistant professor 1964-68,

associate professor 1968-70; Boston University, associate professor to professor 1970- .

Sarah Hanley, *Private interests and public passions in early modern France (1550-1750): a study in social history*.

Born 1937, New York, New York. University of Pittsburgh, BA 1967; University of Iowa, MA 1970, PhD 1975.

University of Iowa, visiting assistant professor 1975-76, assistant professor 1977-82, associate professor 1982- .

Ann Ellis Hanson, *The archive of the collector of capitation taxes in Philadelphia (Fayum, Egypt) during the Julio-Claudian period: texts, translations, and commentary*.

Born 1935, Kalamazoo, Michigan. University of Michigan, BA 1957, MA 1965; University of Pennsylvania, MA 1969, PhD 1971.

University of Michigan, research assistant 1961-63; University of Pennsylvania, teaching fellow 1963-64; Fordham University, Lincoln Center, instructor to associate professor 1968- .

Peter Karavites, *The typology of some ancient Greek treaties*.

Born 1932, Patras, Greece. University of Chicago, MA 1959; Loyola University, PhD 1971.

Loyola University, teaching assistant 1963-69; Appalachian State University, assistant professor 1971-77; Bridgewater State College, associate professor 1978- .

Peter Kranz, *Greek and Roman archaeology*.

Born 1941, Berlin, Germany. University of Bonn, DrPhil 1969; University of Bochum, DrPhilHabil 1980.

Staatliche Kunstsammlungen Kassel, associate curator 1969-71; Philipps-Universität Marburg, wissenschaftlicher Mitarbeiter 1971-74; University of Bochum, wissenschaftlicher Assistent 1974-80, privatdozent 1980-83, professor auf Zeit 1983- .

John Hennig Kroll, *Publication of the Greek coins from the excavations of the Athenian Agora*.

Born 1938, Washington, D.C. Oberlin College, BA 1959; Harvard University, MA 1961, PhD 1968.

Harvard University, lecturer 1969; Agora Excavations, Athens, staff specialist 1970-73;

University of Texas at Austin, assistant professor 1974-77, associate professor 1977- .

Adrian Lyttelton, *The foundation of a nation-state in a fragmented society: liberal Italy 1860-1915*.

Born 1937, London, England. University of Oxford, BA 1959.

University of Oxford, All Souls College, fellow 1960-68; University of Oxford, St. Antony's College, fellow 1968-75; University of Reading, professor 1976-79; Institute for Advanced Study, member fall term 1977-78; The Johns Hopkins University, Bologna Center, professor 1979- .

Phyllis Mack, *Religious culture and gender in early modern England: women and the Quaker movement*.

Born 1939, Buffalo, New York. Barnard College, BA 1961; San Francisco State College, MA 1966; Cornell University, PhD 1974.

Rutgers University, assistant professor 1972-77, associate professor 1977- .

Gareth Blanc Matthews, *Augustine and Descartes: philosophy from a first-person perspective*.

Born 1929, Buenos Aires, Argentina. Franklin College, BA 1951; Harvard University, MA 1952, PhD 1961.

University of Virginia, assistant professor 1960-61; University of Minnesota, assistant to associate professor 1961-69; University of Massachusetts at Amherst, professor 1969- .

Georgi Mihailov, *Ancient Greek epigraphy, history and philology*.

Born 1915, Sliven, Bulgaria. University of Paris IV (Sorbonne), PhD 1948.

University of Sofia, Bulgaria, assistant professor 1941-47, senior assistant professor 1947-57, docent 1957-63, professor 1963- ; British Academy, corresponding fellow 1972; Académie des Inscriptions et Belles-Lettres, France, membre correspondant 1978; Institute for Advanced Study, member 1977-78.

Avraham Negev, *Personal names in the Nabatean realm*.

Born 1923, Pinsk, Poland. Hebrew University, BA 1956, MA 1958, PhD 1972.

Hebrew University, lecturer 1962-67, senior lecturer 1968-72, associate professor 1974-82, professor 1982- .

David Fate Norton, *Critical edition of "A Treatise of Human Nature" by David Hume*.

Born 1937, Hastings, Michigan. Bethel College, BA 1955; Claremont Graduate School, MA 1964; University of California, PhD 1966.

University of California at San Diego, lecturer 1965-66, assistant professor 1966-70, associate professor 1970-71; McGill University, associate professor 1971-81, professor 1981- .

Hans Ulrich Nuber, *Archaeology of the Roman provinces*.

Born 1940, Schwerin (Mecklenburg), Germany. University of Frankfurt, PhD 1968.

University of Frankfurt, assistant 1968, professor 1972-78; University of Heidelberg, visiting professor 1974-76; University of Freiburg, professor and director of department 1978-86; University of Innsbruck, visiting professor 1985.

Dimitri Obolensky, *The impact of Byzantium on medieval eastern Europe*.

Born 1918, Petrograd, Russia. University of Cambridge, BA 1940, MA 1944, PhD 1943; University of Oxford, DLitt 1980.

University of Cambridge, lecturer 1946-48; University of Oxford, reader 1949-61, professor 1961-85; Dumbarton Oaks, Harvard University, visiting scholar 1952, 1964, 1977, visiting fellow 1981-82; Yale University, visiting professor 1957; University of California at Berkeley, visiting professor 1973; Wellesley College, professor 1982.

Jan Ostrowski, *Raffaele Soprani's "Le Vite de' Pittori Genovesi."*

Born 1947, Cracow, Poland. Jagiellonian University, MA 1970; University of Nancy, PhD 1972.

Jagiellonian University, assistant professor 1973-83, associate professor 1983- .

Jennifer Tolbert Roberts, *Ancient and modern historiography*.

Born 1947, New York, New York. Yale College, BA 1971; Yale University, MA 1972, PhD 1976.

Wheaton College, assistant professor 1975-81, chair, department of classics 1979-81; Southern Methodist University, assistant professor 1981-83, associate professor 1983- .

John Scheid, *Roman religious history*.

Born 1946, Luxembourg, Luxembourg.

University of Strasbourg II, Doctorat III^e cycle 1972.

Ecole Française de Rome, member 1974-77; Université de Lille, assistant 1977-82; Ecole Pratique des Hautes Etudes, directeur d'études 1982- .

Nancy Gillian Siraisi, *Concepts of certitude in medieval and Renaissance medicine*.

Born 1932, Catterick, Yorkshire, England. University of Oxford, BA 1953, MA 1958; City University of New York, PhD 1970.

Hunter College, City University of New York, assistant professor 1970-75, associate professor 1975-80, professor 1980- .

Noel M. Swerdlow, *Studies in Ptolemy's astronomy*.

Born 1941, Los Angeles, California. University of California, BA 1964; Yale University, MA 1967, PhD 1968.

University of Chicago, assistant professor 1968-75, associate professor 1975-82, professor 1982- ; Institute for Advanced Study, member 1973-74; University of Toronto, visiting associate professor 1976-77.

Franklin K. Toker, *Cathedral and city in medieval Florence: an archaeological history*.

Born 1944, Montreal, Canada. McGill University, BA 1964; Oberlin College, AM 1966; Harvard University, PhD 1973.

Excavations at Florence Cathedral, director 1969-74; Carnegie-Mellon University, visiting professor 1974-76, associate professor 1976-80; University of Pittsburgh, associate professor 1980- .

Abraham Wasserstein, *Greek (and Greco-Roman) elements in non-Hellenistic ancient Jewry*.

Born 1921, Frankfurt/Main, Germany. University of London, BA 1949, PhD 1951.

University of Glasgow, lecturer 1951-60; University of Leicester, professor 1960-69, dean 1966-69; Hebrew University, professor 1969- ; Institute for Advanced Study, member 1975-76; University of Heidelberg, visiting professor 1980-81, 1983; Oriental Institute, University of Oxford, visiting fellow 1973-74.

Karl-August Wirth, *History of art: iconography and iconology; emblematics*.

Born 1927, Offenbach, Germany. University

of Frankfurt, DrPhil 1953; University of Munich, DrPhilHabil 1970.

Zentralinstitut für Kunstgeschichte, Munich, *Reallexikon zur Deutschen Kunstgeschichte*, co-editor, editor-in-chief, 1954- ; University of Munich, lecturer 1970-74, professor 1974- ; University of Augsburg, professor 1983-84.

Dieter Wuttke, *German humanism and the visual arts.*

Born 1929, Fürstenwalde, Germany. University of Tübingen, DrPhil 1958; University of Göttingen, Habilitation 1971.

Altes Gymnasium Bremen, teacher 1957-62; University of Bonn, stipendiat 1962-66; University of Göttingen, oberstudienrat 1966-71, privatdozent 1971, professor 1971-79; University of Hamburg, visiting professor 1975-76; University of Bamberg, professor 1979- .

Visitors

W. Robert Connor, *Studies in Athenian civic identity.*

Born 1934, Worcester, Massachusetts. Hamilton College, BA 1956; Princeton University, PhD 1961.

University of Michigan, instructor, 1960-63; Princeton University, assistant professor to professor 1964- .

Slobodan Ćurčić, *Byzantine architecture/Architecture of Norman Sicily.*

Born 1940, Sarajevo, Yugoslavia. University of Illinois at Urbana-Champaign, BA 1964, MA 1965; Institute of Fine Arts, New York University, PhD 1975.

University of Illinois at Urbana-Champaign, instructor 1967-68, assistant professor 1971-77, associate professor 1977-82; Princeton University, associate professor 1982-85, professor 1985- .

Robert Gutman, *History of American social thought.*

Born 1926, New York, New York. Columbia University, BA 1946, PhD 1955.

Columbia University, lecturer 1948-49; Dartmouth College, instructor 1948-52, assistant professor 1952-57; Rutgers University, associate professor to professor 1957- , director of Research, Urban Studies Center, 1961-64; Stanford University, visiting professor 1963-64; Swedish National Institute of Building Research, visiting professor 1974; Princeton University, visiting

professor 1969-71, 1975- ; London University, visiting professor 1983; Stockholm University, visiting professor 1983.

David A. Levine, *The art of the "Bamboccianti": ignoble painting in seventeenth-century Rome.*

Born 1951, New York, New York. Oberlin College, BA 1973; Princeton University, MFA 1976, PhD 1984.

Southern Connecticut State University, assistant professor 1979-85, associate professor 1985- .

Robert R. Palmer, *Alexis and Hervé de Tocqueville on the causes of the French Revolution.*

Born 1909, Chicago, Illinois. University of Chicago, PhD 1931; Cornell University, PhD 1934.

Princeton University, instructor to professor 1936-64; Washington University at St. Louis, professor 1964-66; Yale University, professor 1969-77, professor emeritus 1977- ; University of Michigan, visiting adjunct professor 1977-81.

Daniel Robbins, *Recollections of an art loving stockbroker.*

Born 1932, New York, New York. University of Chicago, BA 1951; Yale University, MA 1956; Institute of Fine Arts, New York University, PhD 1974.

Indiana University, teaching associate 1955-56; Hofstra University, lecturer 1956-58; National Gallery of Art, research assistant 1960-61; Solomon R. Guggenheim Museum, assistant curator 1961-65; Museum of Art, Rhode Island School of Design, director 1965-71; Brown University, visiting professor 1966-71; Fogg Art Museum, Harvard University, director 1971-74; Harvard University, lecturer 1971-75; Yale University, visiting lecturer 1977; Williams College, professor 1977-78; Dartmouth College, visiting professor 1975-80; Union College, professor 1980- .

Charles P. Segal, *Myth and folklore in the narrative structure of the Homeric Odyssey.*

Born 1936, Boston, Massachusetts. Harvard College, BA 1957; Harvard University, PhD 1961.

Harvard University, instructor 1963-64; University of Pennsylvania, assistant to associate professor 1964-67; Brown University, associate professor to professor 1980- .

Craig H. Smyth, *Michelangelo and St. Peter's cathedral*.

Born 1915, New York, New York. Princeton University, BA 1938, MFA 1941, PhD 1956.

National Gallery of Art, Washington, D.C., research associate 1941-42; Central Art Collecting Point, Munich, officer-in-charge and director 1945; Frick Collection, New York, lecturer 1946-50; New York University, assistant professor to professor 1950-73, acting director of Institute of Fine Arts 1951-53, director 1953-73; Harvard University, professor 1972-85, director of Villa I Tatti 1973-85; Institute for Advanced Study, member fall 1978, visitor spring 1971, fall 1983.

Fritz Stern, *Modern European history*.

Born 1926, Germany. Columbia College, BA 1946; Columbia University, MA 1948, PhD 1953.

Cornell University, assistant professor 1951-53; Columbia University, assistant professor to professor 1953- ; University of Constance, permanent visiting professor 1967- .

A. Richard Turner, *History of art*.

Born 1932, New Bedford, Massachusetts. Princeton University, BA 1955, MFA 1958, PhD 1959.

University of Michigan, instructor 1959-60; Princeton University, assistant professor to professor 1960-68; Middlebury College, professor 1968-74, chairman of art department 1968-70, dean of the faculty 1970-74; Grinnell College, professor and president 1975-79; New York University, professor 1979- , director of Institute of Fine Arts 1979-82, dean of faculty of arts and science 1982- .

Assistants

Javier Arce, *Late Roman history: the reign of the Emperor Constantius II*.

Born 1945, Zaragoza, Spain. University of Salamanca, Ldo 1969; University of Granada, Dr 1975.

University of Madrid, assistant professor 1970; Institute of Archaeology, High Council of Scientific Research, researcher 1972; Institute for Advanced Study, member spring term 1978-79, assistant to Professor Glen W. Bowersock 1985-86.

Elizabeth Beatson

Born 1915, Worthing, Sussex, England.

Council of Europe Exhibition, Aachen, West Germany, assistant 1965; Zentralinstitut für Kunstgeschichte, Munich, member and part-time research assistant 1965-69; Institute for Advanced Study, assistant to Professor Millard Meiss 1969-76, assistant to Professor Giles Constable 1985- . Princeton University, reader in the Index of Christian Art 1976-85.

Mark Darby, *Medieval political thought*.

Born 1954, Aberdeen, Maryland. Vassar College, BA 1976; Cornell University, MA 1978.

Institute for Advanced Study, assistant to Professor Marshall Clagett 1980-85; Colorado College, instructor 1983.

Catherine Viksjö, *History of art*.

Born 1947, Gary, Indiana. Bryn Mawr College, MA 1977.

Institute for Advanced Study, assistant to Professor Irving Lavin 1985-86.

The School of Mathematics

Faculty

Enrico Bombieri

(IBM von Neumann Professor)

Armand Borel

Pierre Deligne

Robert P. Langlands

John W. Milnor

(Oswald Veblen Professor)

Atle Selberg

Professors Emeriti

Arne Beurling

Deane Montgomery

André Weil

Hassler Whitney

The School of Mathematics

Mathematics, though rooted in human experience, is concerned with relationships between objects and structures that are creations of the mind. What has rigorously been established can therefore not be invalidated by later experience, and so mathematics is cumulative in a way the natural sciences are not. Mathematical truths established in antiquity by Apollonius, Archimedes or Euclid are still alive and well and part of the body of mathematics today.

However, while the substance or content remains, the form in which it is presented is transitory and may change profoundly from one generation to the next. The landscape of mathematics is ever changing and the boundary lines between different areas are fluid. As mathematics develops there are tendencies of divergence, complexification, and fragmentation, as well as of unification and simplification.

Some areas may branch out in several different directions and divide into various specialties with little or no contact between them. It may also happen that new concepts and deeper insights bring together subjects that seemed far apart and unrelated, fitting them together in a new scheme of things, at once grander and simpler.

Mathematics, while it deals with objects of the mind, may be brought to bear on models of reality arising in other sciences. It has thus for a long time had a close relationship with physics and astronomy in particular. Historically, many mathematical concepts and theories have evolved because of stimuli provided by questions originating in these sciences. On the other hand, the mathematician's pursuit of a purely intellectual pastime has often led to concepts and theories which later turned out to have anticipated vital needs of these sciences in an almost uncanny way.

The areas of mathematics that most frequently draw their inspiration from problems in the natural sciences are commonly referred to as applied mathematics, as distinct from pure mathematics, but it is a distinction primarily of motivation or attitude rather than of essence.

Even in the branches of mathematics usually thought of as the purest, experimentation and empirical evidence have always played an important role in the discovery of new relationships. Today the development of the electronic computer has made such experimentation and the gathering and processing of empirical data possible on a scale far beyond anything seen or even imagined before. The consequences of this are already very noticeable in some areas, and this development is bound to affect mathematics much more profoundly in the future.

While it is true that great mathematics has sometimes been done in isolation under adverse circumstances, as a rule free communication and lively exchange of ideas between mathematicians are essential prerequisites for mathematical progress. Since antiquity, there have from time to time come into being centers that were the foci of the mathematical intercourse of their day.

In the nineteenth century, Paris, Berlin and Göttingen were such centers, with Göttingen gradually gaining the ascendancy and retaining this position of primacy until it came to an end with the Nazi regime. A contributing factor to the dominant position of Göttingen, beside its traditions and an excellent, though small, faculty, was probably the unusually large number of junior temporary positions available there.

The School of Mathematics of the Institute for Advanced Study started out as Göttingen and the other German universities went into

decline, and it benefited from the exodus of eminent scholars and scientists from Germany which started in 1933. Its earliest Faculty included three of the leading American mathematicians of the time: Oswald Veblen, James W. Alexander and Marston Morse. From Germany, Hermann Weyl from Göttingen and John von Neumann and Albert Einstein from Berlin joined the School. Later Kurt Gödel from Vienna and Carl Ludwig Siegel from Göttingen were added.

Under the guidance primarily of Veblen and Weyl, and drawing on experiences from Göttingen, the School developed a pattern of operation which put the emphasis on having a mix of temporary members with varied interests and at various stages in their mathematical career. The temporary members were thought of as the most important element, the real *raison d'être*, of the School, and the Faculty considered it a prime obligation to be freely available to the temporary members for consultation and advice. There was little in the way of formal organization, but as the interests of the temporary members and the Faculty might dictate, seminars and lecture series were arranged in which the members could participate or not according to their wishes, and otherwise do their own research. During these early years the School also, to some extent, served as a clearing house for refugee mathematicians, receiving them for a time and helping to ease their absorption into the American university system. For many years after the end of World War II, the School was still the only international center devoted solely to postdoctoral studies and research in mathematics.

The School of Mathematics was, and still is, very much assisted by the presence at Princeton University of a very strong mathematics department, creating a local mathematical community much larger than the School by itself could provide. The informal cooperation with the University department has always been most beneficial; the only formal link between the two is that they jointly edit the *Annals of Mathematics*, the leading American mathematical journal.

The School has later largely continued the

pattern of operation established in the early years, though as the membership has grown the number of seminars and lectures has increased.

In the sixties the School initiated a policy of having special programs during some academic years, by selecting some specific area that looked particularly promising at the time, and bringing together a group of mathematicians with interests in or around this area, but without letting the special program take over completely. A sizable number of the membership was always selected that had no particular connection with the program. During the seventies this policy was discontinued for a while due to lack of funding, but was later resumed. The School now has special programs on the average every second year.

More recently an aperiodic series of survey lectures, called the Hermann Weyl Lectures, was instituted. These lectures consist of a broad survey of recent work in some area of mathematics of particular current interest, and are later published in the *Annals of Mathematics Studies*.

Both the special programs and the Hermann Weyl Lectures can serve as a way to stimulate research in areas beyond those represented by the School's Faculty. This function is important since the Faculty at no time has covered all vital areas of mathematics, though the coverage has shifted considerably over the years.

One characteristic feature of the School that has helped to keep it strong through the years and changes, is a highly developed "esprit de corps." Today, when several other centers devoted solely to mathematical research exist, it is still the ambition of the School Faculty that the School of Mathematics shall remain, as Hermann Weyl described it in 1954: "die schönste Forschungsstätte die es für die Mathematik in der Welt gibt."

Academic Activities, 1985-86

This year was a very active one for the School of Mathematics. Two special programs had been organized.

One dealt with Diophantine approximation

and related problems. Diophantine approximation is a theme that goes back a long way. Originally the subject dealt with the question of how well a given real number could be approximated by fractions or rational numbers measured by the size of the denominator of the fraction. More generally one studied the approximate solutions in integers of under-determined systems of linear equations with real coefficients. This subject has strong affinities with and applications to the theory of Diophantine equations: the problem of finding integer solutions to polynomial equations with integral coefficients. It also has strong connections with the methods used in deciding whether various numbers given by mathematical expressions of a non-algebraic nature are transcendental. We say a number is transcendental if it is not the solution of any polynomial equation with integral coefficients. For instance, the fundamental mathematical constants e and π were early shown to be transcendental. Beyond the question of transcendence of a single such number, one also tries to establish whether one has algebraic independence between several, say n , such numbers; this means that there is no polynomial in n variables with integral coefficients which vanishes when one replaces the n variables with the given n numbers.

While these subjects have a long history by now, there were two very substantial breakthroughs around 1970 by Alan Baker and Wolfgang Schmidt. More recently powerful new techniques from commutative algebra and algebraic geometry have been introduced by Nesterenko, Masser, Wüstholz, Philippon and Brownawell.

This year's special program in Diophantine approximation was arranged with the participation of the leading specialists in the field. It was very successful and produced many new results. The publication of a volume containing these results is planned.

The other special program was in D-modules. D-modules started in the sixties as a tool to investigate systems of linear partial differential equations, with the emphasis more on

the algebraic properties of the equations than on the properties of solutions. More recently, due to work of M. Goresky and R. MacPherson, D-modules have become an essential tool for understanding singular spaces, and have provided a link between infinite dimensional representations of a semisimple Lie group and the geometric properties of singular spaces attached to that group.

The program on D-modules brought together mathematicians interested in various aspects of D-modules. Some emphasis was also given to the applications to representation theory since representation theory has been a strong focus of interest in the School over many years.

In connection with each of these special programs, a series of seminars was organized. In addition, series of seminars in Topology and Dynamical Systems were also organized.

This year there were two series of Hermann Weyl Lectures: in the fall term by Luis A. Caffarelli on "Free boundary problems, a survey" and in the spring term by David Vogan on "Unitary representations of semisimple groups." The Marston Morse Memorial Lecture was given by Alan Weinstein on "Symplectic geometry and the calculus of variations."

Besides these there were various other special lectures, including a series of introductory lectures on String theory by Edward Witten.

Apart from these organized activities the Visiting Members and the Faculty of the School engaged in informal interchanges and discussions and pursued their own research either individually or in collaboration.

There was some upgrading of computer capabilities in the School during 1985-86. Two IBM PC-AT's and three IBM PC-XT's were put into use, and two Sun-2 workstations were installed during the year. In addition, toward the end of the year, a network was set up joining these Sun's with the Consortium for Scientific Computing/John von Neumann Center and with two Sun-3's in Fuld Hall. These machines are now in heavy use.

The School of Mathematics

Members, Visitors and Assistants, 1985-86

In the section which follows, the information was obtained from material provided by the Members, Visitors and Assistants.

Members

Samuel O. Ajala, *Smooth structures on manifolds.*

Born 1948, Ile-Gbo, Oyo State, Nigeria. University of Ibadan, BSc 1973; University of California at Berkeley, MA 1977, PhD 1979. University of Lagos, lecturer 1980- .

Robert Bédard, *Representation theory of Hecke algebras.*

Born 1956, St.-Jean-sur-Richelieu, Québec, Canada. University of Montreal, BSc 1978; Massachusetts Institute of Technology, PhD 1983. University of Montreal, postdoctoral fellow 1983- .

Martin Bendersky, *BP obstruction theory for embedding and immersions.*

Born 1945, New York, New York. City College of New York, BS 1966; University of California at Berkeley, PhD 1971.

Aarhus University, instructor 1971-72; University of Washington, assistant professor 1972-80; Rider College, associate professor 1980- .

Joseph N. Bernstein, *D-modules, representation theory.*

Born 1945, Moscow, USSR. Moscow State University, BA and MA 1968, PhD 1972.

Moscow State University, junior research fellow 1971-78; University of Maryland, visiting professor 1981-82; Harvard University, professor 1983- .

Shrikant M. Bhatwadekar, *Projective modules and complete intersection ideals.*

Born 1946, Pune, Maharashtra State, India. Pune University, BSc 1966; University of Bombay, MSc 1968, PhD 1975. Tata Institute of Fundamental Research,

research assistant 1968-73, research associate 1973-74, research fellow 1974-77, fellow 1977-86; University of Kentucky, visiting assistant professor 1984-85.

W. Dale Brownawell, *Transcendental number theory.*

Born 1942, Grundy County, Missouri. University of Kansas, BA 1964; Cornell University, MA 1968, PhD 1970.

Pennsylvania State University, assistant professor to professor 1970- ; University of Colorado, visiting associate professor 1974-75; University of Paris VI, visiting professor March 1978, June 1982, June 1984; Ecole Polytechnique, maître de recherche, fall 1984.

Alberto Buffo, *Mathematical physics.*

Born 1954, Bahia Blanca, Argentina. University of California, PhD 1985.

Latin American School of Mathematics, Brazil, 1976; University del Sur, Argentina, assistant 1976-77; University of California at Berkeley, research assistant 1982.

Daniel W. Bump, *Automorphic forms.*

Born 1952, Portland, Oregon. Reed College, BA 1974; University of Chicago, MS 1975, PhD 1982.

University of Texas at Austin, lecturer 1983-85; University of Rochester, visiting assistant professor, fall 1984.

Pascal Cherrier, *Analysis on manifolds.*

Born 1950, Paris, France. University of Paris VI, Docteur ès Sciences 1981.

University of Limoges, assistant professor 1975-79; University of Paris Nord XIII, assistant to master assistant to professor 1979- ; University of California, scholar 1983.

Jack F. Conn, *Geometric equivalence problems and systems of partial differential equations.*

Born 1952, Minneapolis, Minnesota. Harvard College, AB 1973; Princeton University, PhD 1978.

Institute for Advanced Study, member 1977-78; California Institute of Technology, assistant professor 1978-85; Mathematical Sciences Research Institute, Berkeley, member 1982-83; University of Minnesota, associate professor 1986- .

George Christopher Cosner, *Nonlinear elliptic and parabolic partial differential equations*.

Born 1952, Los Angeles, California.

University of California at San Diego, BA 1973; University of California at Berkeley, MA 1975, PhD 1977.

Texas A & M University, assistant professor 1977-82; University of Miami, associate professor 1982-85.

Lawrence Corwin, *Harmonic analysis on nilpotent lie groups; discrete series representations for GL_n over the p -adics*.

Born 1943, East Orange, New Jersey. Harvard University, BA 1964, MA 1965, PhD 1968.

Massachusetts Institute of Technology, instructor 1968-70; Courant Institute, New York University, visiting member 1970-71; Yale University, assistant professor 1971-75; Institute for Advanced Study, member 1973; Rutgers University, associate professor 1975-80, professor 1980- .

Ethan M. Coven, *Dynamical systems*.

Born 1942, Brooklyn, New York. University of Rochester, BA 1962; Yale University, MA 1964, PhD 1967.

Wesleyan University, assistant professor to professor 1967- .

Louis Crane, *Quantum gravity as a fractal; supermanifolds*.

Born 1949, Chicago, Illinois. University of Chicago, BA 1968, MA 1970, PhD 1985.

University of Illinois, teaching assistant 1980-82; University of Chicago, lecturer 1982-84, research assistant 1984.

Michael Cwikel, *Functional analysis; interpolation of operators*.

Born 1948, Melbourne, Australia. University of Melbourne, BSc 1969; Flinders University of South Australia, MSc 1970; Weizmann Institute of Science, PhD 1973.

Institute for Advanced Study, member 1975-76; Technion, Israel Institute of Technology,

lecturer 1976-78, senior lecturer 1978-85, associate professor 1985- .

John P. D'Angelo, *Several complex variables and geometry of real hypersurfaces*.

Born 1951, Philadelphia, Pennsylvania. University of Pennsylvania, BA 1972; Princeton University, PhD 1976.

Massachusetts Institute of Technology, instructor 1976-78; University of Illinois, assistant professor 1978-81, associate professor 1981- ; Princeton University, visiting associate professor 1983.

Eric M. Friedlander, *Cohomology and representation theory of algebraic groups and related structures*.

Born 1944, Santurce, Puerto Rico.

Swarthmore College, BA 1965; Massachusetts Institute of Technology, PhD 1970.

Princeton University, instructor to assistant professor 1970-75; Northwestern University, associate professor to professor 1975- ; Institute for Advanced Study, member spring 1981.

Sam Gitler, *Algebraic topology and supermanifolds*.

Born 1933, Mexico City, Mexico. University of Mexico, BA 1956; Princeton University, PhD 1960.

Brandeis University, instructor 1960-62; Centro de Investigacion, IPN, Mexico, professor 1965- ; Institute for Advanced Study, member 1964-65.

Marcelo E. Gomez, *Harmonic analysis; partial differential equations*.

Born 1955, Buenos Aires, Argentina. Buenos Aires University, BA 1976, PhD 1983.

Buenos Aires University, instructor 1976-82, assistant professor 1982- .

Robert Mark Goresky, *Intersection homology and representation theory*.

Born 1950, Regina, Saskatchewan, Canada. University of British Columbia, BSc 1971; Brown University, PhD 1976.

University of British Columbia, assistant professor 1978-81; Northeastern University, assistant professor 1981-83, associate professor 1983- .

Richard M. Hain, *The De Rham homotopy theory of algebraic varieties*.

Born 1953, Sydney, Australia. University of Sydney, BSc 1976; Australian National University,

MSc 1977; University of Illinois, PhD 1980.

University of Washington, instructor 1980-83; University of Utah, visiting assistant professor 1983-84; State University of New York at Buffalo, assistant professor 1984-85; University of Washington, assistant professor 1985- .

Jean-Claude Hausmann, *Topology of Poincaré spaces.*

Born 1945, St.-Croix, Switzerland. University of Geneva, PhD 1974.

University of Geneva, assistant to professor 1976-86; University of California at Berkeley, research fellow summer 1976; University of Warwick, research fellow summer 1979; Max-Planck-Institut, Bonn, member fall 1985; Institute for Advanced Study, member 1975-76, 1978-79.

Dennis A. Hejhal, *Automorphic forms; Dirichlet series; supercomputers.*

Born 1948, Chicago, Illinois. University of Chicago, BS 1970; Stanford University, PhD 1972.

Harvard University, assistant professor 1972-74; Columbia University, associate professor 1974-78; University of Minnesota, professor 1978- ; Institute for Advanced Study, member fall 1983, fall 1984.

Adolf Hildebrand, *Analytic number theory.*

Born 1956, Leutkirch, West Germany. University of Freiburg, DrRerNat 1983; University of Paris-Sud, Orsay, Doctorat d'Etat 1984.

University of Paris-Sud, fellow 1981-83; University of Illinois, fellow 1983-85.

Nancy Hingston, *Differential geometry and topology; closed geodesics.*

Born 1953, New Rochelle, New York. University of Pennsylvania, BA 1975; Harvard University, PhD 1981.

University of Pennsylvania, assistant professor 1981- ; State University of New York at Stony Brook, visiting assistant professor fall 1983.

Jeffrey Hoffstein, *Metaplectic forms on $GL(n)$.*

Born 1953, New York, New York. Cornell University, BA 1974; Massachusetts Institute of Technology, PhD 1978.

Institute for Advanced Study, member 1978-79; Brown University, assistant professor 1980-82; University of Rochester, assistant to associate professor 1982- .

Johannes Huebschmann, *Cohomology ring of an induced fibre space; cohomology of nilpotent groups.*

Born 1950, Heidelberg, West Germany. Eidgenössische Technische Hochschule, Zürich, Diplom 1974, PhD 1977; University of Heidelberg, Habilitation 1984.

University of Heidelberg, assistant 1976-85, Heisenberg scholar 1985- .

Henryk Iwaniec, *Analytic number theory; automorphic functions.*

Born 1947, Elblag, Poland. University of Warsaw, PhD 1972; Mathematics Institute, Polish Academy of Sciences, Habilitation 1976, Professor 1983.

Mathematics Institute, Polish Academy of Sciences, associate assistant 1972-78, associate professor 1978-83, professor 1983- ; Institute for Advanced Study, member 1983-84.

W. David Joyner, *Motives and automorphic forms.*

Born 1959, Philadelphia, Pennsylvania. Georgia Institute of Technology, BS 1981; University of Maryland, PhD 1983.

University of Maryland, instructor 1984; University of California at San Diego, assistant professor 1984-85; Princeton University, instructor 1985-86.

Ittai Kan, *Dynamical systems.*

Born 1956, New York, New York. Massachusetts Institute of Technology, BS 1978; University of Illinois at Urbana, PhD 1984.

University of Michigan at Ann Arbor, visiting assistant professor 1984-85.

Dimitry Kanevsky, *Rational points on cubic surfaces.*

Born 1952, Kiev, USSR. Moscow State University, MSc 1975, PhD 1976.

Tel Aviv University, researcher 1979-81; Weizmann Institute of Science, postdoctoral fellowship 1981-83; Max-Planck-Institut, Humboldt fellow 1983-84; Institute for Advanced Study, 1984-85.

William M. Kantor, *Affine buildings; algebraic algorithms.*

Born 1944, Brooklyn, New York. Brooklyn College, BS 1964; University of Wisconsin, MA 1965, PhD 1968.

University of Illinois at Chicago Circle, assistant to associate professor 1968-71; University

of Oregon, associate professor 1971-77, professor 1977- .

Benjamin L. Lichtin, *D-modules and applications to singularities and number theory*.

Born 1953, Cincinnati, Ohio. University of Cincinnati, BS 1972; Ohio State University, MA 1973, PhD 1978.

Institute for Defense Analysis, technical staff member 1979-80; Institute for Advanced Study, member 1980-81; Harvard University, visiting scholar 1982-83; University of Rochester, assistant professor 1983- .

Ming-Chit Liu, *Analytic number theory and analysis*.

Born 1937, Macao. The Chinese University of Hong Kong, BSc 1965; University of Hong Kong, MSc 1969, PhD 1973.

University of Hong Kong, assistant lecturer 1971-73, lecturer 1973-83, reader 1983- ; Institute for Advanced Study, member fall 1980.

Richard N. Lyons, *Finite simple groups*.

Born 1945, New York, New York. Harvard College, BA 1966; University of Chicago, MS 1967, PhD 1970.

Yale University, instructor 1970-72; Rutgers University, assistant professor to professor 1972- ; Institute for Advanced Study, member fall 1978.

Robert MacPherson, *Topology of algebraic varieties*.

Born 1944, Lakewood, Ohio. Swarthmore College, BA 1966; Harvard University, MA 1970, PhD 1970.

Brown University, instructor to professor 1970- .

Bernard Malgrange, *Partial differential equations; singularities*.

Born 1928, Paris, France. University of Paris, Docteur ès Sciences 1955.

University of Strasbourg, professor 1955-60; University of Orsay, professor 1960-69; University of Grenoble, professor 1969-74; Centre Nationale de la Recherche Scientifique, researcher 1974- .

David Masser, *Transcendental numbers and related topics*.

Born 1948, London, England. Trinity College, University of Cambridge, BA 1971, MA 1974, PhD 1974.

University of Nottingham, lecturer 1974-83; University of Michigan, professor 1983- .

Attila Máté, *Orthogonal polynomials; logic*.

Born 1946, Szeged, Hungary. Szeged University, BS 1968, PhD 1971.

Mathematical Institute, Budapest, Hungary, research associate 1973-75; University of Michigan, visiting assistant professor 1975-76; University of North Carolina, visiting assistant professor 1976-77; Rutgers University, lecturer 1977-78; Brooklyn College, City University of New York, assistant professor to professor 1978- .

Zoghman Mebkhout, *D-modules theory*.

Born 1948, Mecheria, Algeria. University of Paris, Doctorat d'Etat 1975.

Centre Nationale de la Recherche Scientifique, researcher 1982- .

Dragan Milićić, *Representation theory of semisimple Lie groups*.

Born 1948, Zagreb, Yugoslavia. University of Zagreb, BS 1969, MS 1971, PhD 1973.

University of Zagreb, assistant 1969-73, docent 1973-77, associate professor 1977-80; Institute for Advanced Study, member 1975-76; University of Utah, associate professor 1980-83, professor 1983- .

Ivan Mirković, *Applications of D-modules in group representations*.

Born 1954, Zagreb, Yugoslavia. University of Zagreb, BA 1977, MA 1981; University of Utah, PhD 1985.

University of Zagreb, assistant 1977-81; University of Utah, teaching fellow 1981-85.

V. Kumar Murty, *Modular forms*.

Born 1956, Guntur, India. Carleton University, BSc 1977; Harvard University, PhD 1982.

Institute for Advanced Study, member 1982-83; Tata Institute of Fundamental Research, member 1983- .

Masayoshi Nagase, *Global analysis on stratified Riemannian spaces*.

Born 1954, Gunma, Japan. University of Tokyo, BS 1979; Tokyo Institute of Technology, MS 1981, PhD 1984.

Tokyo Institute of Technology, assistant 1984.

Andrew J. Nicas, *Algebraic and geometric topology*.

Born 1957, Ottawa, Canada. McGill University, BSc 1976; Princeton University, PhD 1979.

Brandeis University, assistant professor 1980-83; University of Toronto, assistant professor 1983- .

Kiyoshi Niino, *Complex analysis*.

Born 1941, Maizuru, Japan. Kanazawa University, BA 1963; Tokyo Institute of Technology, MA 1965, Doctor of Science 1971.

Tokyo Institute of Technology, research associate 1966-72; Yokohama National University, associate professor 1972-79; Kanazawa University, associate professor 1979-82, professor 1982- .

Madhav V. Nori, *Algebraic cycles*.

Born 1949, Baroda, Gujarat, India. University of Bombay, BSc 1969, PhD 1981; University of California at Berkeley, MA 1972.

Tata Institute of Fundamental Research, research assistant 1972-84, associate professor 1985- ; Institute for Advanced Study, member 1975-76; University of Chicago, visiting assistant professor 1984-85.

Patrice Philippon, *Transcendental number theory*.

Born 1954, Cren, France. Université de Cren, Maîtrise ès Science Mathématique; Ecole Polytechnique de Palaiseau, Ingénieur Diplômé 1978; University of Paris XI, Orsay, doctorat 3^{ème} cycle 1980, doctorat d'état 1983.

Centre Nationale de la Recherche Scientifique, attaché de recherche 1981-82, chargé de recherche 1983-85, boursier échange NSF at Harvard 1985.

Ravi A. Rao, *Projective modules over polynomial rings: Plumstead's conjecture*.

Born 1954, Bombay, India. Bombay University, MSc 1976, PhD 1984.

Tata Institute for Fundamental Research, fellow 1984- ; University of Chicago, instructor 1984-86.

Siddhartha Sahi, *Representations of reductive Lie groups*.

Born 1958, Allahabad, India. Delhi University, BSc 1979; Yale University, MA/MPhil 1981, PhD 1985.

Morihiko Saito, *D-modules and Hodge theory*.

Born 1954, Matsuyama, Japan. University of Tokyo, BA 1978, MA 1980.

Fourier Institute, maître de recherche; University of Leiden, researcher; Université de

Nice, chargé de recherche 1984-85; Max-Planck-Institut, researcher 1985.

Makoto Sakai, *Complex analysis and potential theory*.

Born 1943, Tokyo, Japan. Yokohama National University, BS 1966; Tokyo Institute of Technology, MA 1968, PhD 1976.

Tokyo Institute of Technology, assistant 1969-74; Hiroshima University, assistant professor 1974-81; Tokyo Metropolitan University, associate professor 1981- .

Jonathan W. Sands, *Iwasawa theory*.

Born 1955, Boston, Massachusetts. Harvard College, BA 1977; University of California at San Diego, MA 1979, PhD 1982.

University of Maine at Orono, assistant professor 1982-85.

Wolfgang M. Schmidt, *Number theory*.

Born 1933, Vienna, Austria. University of Vienna, PhD 1955.

University of Colorado, associate professor 1964, professor 1965- ; Institute for Advanced Study, member 1970-71.

Mark Sheingorn, *Number theoretic aspects of geodesics on modular surfaces*.

Born 1944, New York, New York. Dartmouth College, BA 1965; University of Wisconsin, MA 1967, PhD 1970.

University of Wisconsin, NASA fellow 1966-68; National Bureau of Standards, Washington, D.C., researcher 1970-72; Baruch College, City University of New York, assistant professor 1974-78, professor 1978-85; University of Illinois, visiting lecturer 1979; Institute for Advanced Study, member 1974, visitor 1981; State University of New York at Stony Brook, visiting professor 1983.

Stevo Todorcević, *Set theory: partition properties of the uncountable*.

Born 1955, Mrkonjić Grad, Yugoslavia. University of Beograd, BA 1977, MS 1978, PhD 1979.

Mathematicki Institut, Beograd, assistant 1979-80; The Hebrew University of Jerusalem, visiting assistant professor 1980; University of Toronto, visiting scholar 1980; Dartmouth College, visiting scholar 1980-81; University of Colorado at Boulder, assistant professor 1981-83; University of California at Berkeley, research fellow 1983-85.

Robert Tubbs, *Transcendental number theory.*

Born 1954, South Haven, Michigan.

University of South Florida, BA 1975; Columbia University, MA 1978; Pennsylvania State University, PhD 1981.

Claremont Graduate School, Pitzer College, assistant professor 1981-84; University of Texas at Austin, instructor 1984- .

Bert van Geemen, *Geometry and arithmetic of Abelian varieties.*

Born 1958, Groenlo, The Netherlands. State University of Utrecht, Drs 1981, Dr 1985.

State University of Utrecht, research assistant 1981-85, university docent 1985- .

Michel Waldschmidt, *Transcendental number theory.*

Born 1946, Nancy, France. University of Bordeaux, Thèse d'Etat 1972.

University of Bordeaux, assistant 1968; University of Paris Sud, Orsay, chargé d'enseignement 1972-73; University of Paris VI, maître de conférences 1973-77, professeur 1977- .

Yuan Wang, *Diophantine equations and analytic number theory.*

Born 1930, Zhe-Jiang, China. Zhe-Jiang University, BA 1952.

Institute of Mathematics, Academia Sinica, Beijing, assistant 1952-56, lecturer 1956-63, associate professor 1963-78, professor 1978- .

Charles A. Weibel, *Algebraic K-theory.*

Born 1950, Terre Haute, Indiana. University of Michigan, MS and MA 1972; University of Chicago, PhD 1977.

Institute for Advanced Study, member 1977-78; University of Pennsylvania, assistant professor 1978-80; Rutgers University, assistant professor 1980-83, associate professor 1983- .

Gisbert Wüstholz, *Transcendence, arithmetic algebraic geometry.*

Born 1948, Tuttlingen, West Germany.

University of Friburg, DrRerNat 1977; University of Wuppertal, Habilitation 1983.

University of Freiburg, assistant 1973-77; University of Wuppertal, assistant 1978-83, professor 1985- ; University of Bonn, research fellow 1977-78; Max-Planck-Institut, Bonn, research professor 1983-85.

Virginia Ruth Young, *Algebraic topology.*

Born 1960, Honolulu, Hawaii. Cumberland College, BA 1981; University of Virginia, PhD 1984.

Visitors

Julia Mueller, *Diophantine equations and Diophantine approximation.*

Born 1944, China. University of Rochester, BS 1965; Columbia University, MA 1974, PhD 1976.

Institute for Advanced Study, member 1976-77, assistant 1981-82; Columbia University, visiting scholar 1977-78; Brooklyn College, instructor 1978-79; Fordham University, assistant professor 1979- .

Daniel Saracino, *Model-theoretic algebra.*

Born 1947, Ellenville, New York. Cornell University, BA 1968; Princeton University, PhD 1972.

Yale University, instructor 1972-74; Colgate University, assistant professor to professor 1974- .

Hans B. Sieburg, *Transcendental number theory; mathematical models for the immune system.*

Born 1953, Cologne, West Germany. University of Cologne, Dipl 1981, PhD 1983.

University of Cologne, assistant 1981-83; Stanford University, visiting assistant professor 1983-85.

Jan-Olov Strömberg, *Harmonic analysis: Weighted Hardy spaces on Maximal functions.*

Born 1947, Bo, Sweden. University of Stockholm, Fil kand 1969; University of Uppsala, Fil dr 1977.

Princeton University, instructor 1977-79, assistant professor 1979-82; University of Stockholm, Forskar assistent 1980-82; University of Tromsø, professor 1982- ; Rutgers University, visiting professor 1985-86.

Carol S. Wood, *Model-theoretic algebra.*

Born 1945, Pennington Gap, Virginia. Randolph-Macon Woman's College, BA 1966; Yale University, PhD 1971.

University of Erlangen at Nürnberg, gastdozent 1971-72; Yale University, instructor 1972-73, visitor 1977-78, fall 1981; Wesleyan University, assistant professor to associate professor 1973- ; Institute for Advanced Study,

member spring 1982; Rutgers University, associate research professor 1985-86.

Assistants

K. Gopalaiyer Ramanathan, *Manuscripts of Srinivasa Ramanujan; modular forms and series.*
Born 1920, Hyderabad, A.P., India. Madras University, MA 1941, MSc 1945; Princeton University, PhD 1951.

Annamalai University, lecturer 1945-46; Osmania University, lecturer 1947-48; Tata Institute of Fundamental Research, reader, associate professor, professor 1952-62, senior professor 1970- ; Washington University at St. Louis, visiting professor 1964-65; Rutgers

University, visiting professor 1969-70; Institute for Advanced Study, member 1948-51, 1961-62, 1981-82, assistant to Professor Atle Selberg 1985-86.

Cihan Saclioglu, *Mathematical physics.*

Born 1948, Istanbul, Turkey. Middle East Technical University, Ankara, Turkey, BSc 1970; University of Chicago, PhD 1974.

University of Oxford, research associate 1974-76; Middle East Technical University, Ankara, lecturer 1976-77; Bogazici University, Istanbul, associate professor 1977-84; Yale University, visiting professor 1978-79; Bonn University, visiting professor 1980-82; Institute for Advanced Study, assistant to Professor Robert Langlands 1985-86.

The School of Natural Sciences

Faculty

Stephen L. Adler
(New Jersey Albert Einstein Professor)
John N. Bahcall

Roger Dashen
Freeman J. Dyson
Piet Hut

Permanent Member

Julian H. Bigelow

Members with Long-term Appointments

Michael Dine
Herman H. Goldstine
Jeremy Goodman
Otto E. Neugebauer
Tsvi Piran

Donald Schneider
Andrew E. Strominger
Stephen Wolfram
Tim de Zeeuw

The School of Natural Sciences

Over time, the School of Natural Sciences has come to concentrate on two fundamental areas: the physics of the very small (meaning elementary particle physics, high energy physics and field theory) and the physics of the very large (astrophysics and general relativity).

Within the category embraced by the physics of the very small is a family of fascinating problems and processes. The problem of resolving the increasingly finer problems of the structure of matter has called for smaller and smaller probing fingers or wavelengths. In turn, this has demanded larger and larger probing energies so that high energy physics, the physics of the big machines, has become synonymous with the physics of elementary particles. From a theoretical point of view this requires the simultaneous reconciliation of quantum mechanics with Einstein's special relativity, that is, of defining a reality in which the transformation of matter into energy holds, according to the famous formula $E = mc^2$, even though according to quantum mechanics there is an uncertainty in determining the energy of a system because an arbitrarily large number of particles is involved, which leads to systems with infinite degrees of freedom. Quantum electrodynamics, which is the system describing the interaction between electrons and photons (or in field language, the interaction of the electron with the electromagnetic field), was one response to this situation. Unfortunately, it did not prove adequate to the task of dealing with the four basic types of particle interactions: the electromagnetic, the strong forces which hold the nucleus together, the weak forces responsible for β -decay in radioactivity, and gravitation. Quantum electrodynamics has now been sub-

sumed into a more general framework, the electroweak theory, which unifies two of these forces. A separate generalization of electrodynamics, called quantum chromodynamics, is by now believed to be the correct theory of the strong force. The latter involves what is perhaps the most complex (but subtle) set of equations ever contemplated by scientists. Considerable work at the Institute is directed toward extracting the consequences of this theory. It is hoped that someday quantum chromodynamics can be combined with the electroweak theory to produce a so-called grand unified theory and that someday gravity can also be incorporated. A number of Institute members work in this area. The history and discussion of modern particle theory at the Institute are thus attempts to find ways of developing a satisfactory theoretical understanding of particles and their interactions.

In dealing with the physics of the very large, which is the second major area of interest within the School of Natural Sciences, the astronomer faces problems whose conditions are separate and distinct from the general practice of science. Unlike the physicist who deals with the very small, the astronomer has no access to controlled laboratory experiments. His knowledge is derived from distant objects, which up to the Second World War were exclusively optical in character. The new technologies which were spawned during the war bloomed rapidly in the years that followed, broadening the spectrum of observable phenomena to include the radio spectrum, the infrared, the ultraviolet, X-ray and gamma-ray astronomy, and even the possibility of neutrino and gravitational radiation.

Changing observational methods have also led to the discovery or prediction of new as-

tronomical objects such as neutron stars, black holes, pulsars (later identified as neutron stars), quasi-stellar objects such as quasars as well as the continuing study of old familiars such as novae, supernovae and white dwarfs. Of equal interest has been the study of the interstellar medium, important because of its influence on the transmission of radiation signals, and the cosmic black body radiation which once filled the universe in an earlier, hotter stage of its expansion. For astrophysicists, general relativity theory thus assumes great importance as they come to grips with the gravitational effects of very large masses. Small well-known deviations from Newtonian predictions within the solar system have been delineated by general relativity theory, but its greatest importance lies in the physics of neutron stars, black holes and theories of cosmic evolution. These revolutionary developments in astronomy have rekindled the interest in general relativity, so that Einstein's work remains at the edge of contemporary science as a vigorous research frontier.

Under these rather sweeping rubrics, the work of the School of Natural Sciences concentrates on particular areas: neutrino astronomy, galactic evolution, star counts, stellar dynamics, supernovae, compact X-ray sources, neutron stars and black holes. Additionally, quasars as the most distant objects, and the recently discovered rings of Uranus as some of the nearest, have occupied the research attention of the astrophysics group. The group also specializes in predicting what the Space Telescope will see at the very faint levels of light and in the new parts of the spectrum that will be accessible from this first permanent international observatory in space.

Academic Activities, 1985-86

A. Particle Physics

A large part of the high energy physics activity centered on the new superstring theories, which are attracting much attention as candidates for the sought-after "Theory of

Everything," which would unify the strong, electro-weak and gravitational forces. Jevicki, in collaboration with Gross (Princeton University) worked on various aspects of string field theory, obtaining an operator construction of the interaction vertex and other elements entering into the field theory recently proposed by Witten. Bagger studied the question of the superstring vacuum, concentrating on twisted strings, and with Callan, Dixon and Harvey (Princeton University) found that certain phases which appear are determined by fermion fractionization. Mueller (with Witten, Princeton University) studied certain compactifications of the heterotic string which involve vacuum expectation values of the massless antisymmetric tensor. Morris and Burgess studied in detail the structure of nonorientable and open string theories; the orders of perturbation theory were clarified and the role of Teichmüller parameters and modular transformations were made explicit, and the one loop cosmological constant was shown to be zero for any $SO(N)$ gauge group. Spiegelglas studied general properties of BRST operators, and found general conditions under which BRST cohomology eliminates negative metric states from the Hilbert space; this can be applied to proving the no-ghost theorem in string theory. Fairlie and Manogue investigated a parameterization of the string, based on the multiplicative norm property of division algebras, which automatically solves the nonlinear constraint equations in spacetimes of certain dimensionalities. Labastida demonstrated the equivalence of dual field theoretical limits of superstring theories by utilizing a generalized duality transformation.

During the Fall Semester of 1985, several of the world's leading experts in the perturbation theory of quantum chromodynamics (QCD—the theory of the strong force) were in residence. Mueller wrote a review of perturbative QCD, based on lectures which he had given earlier, and also wrote a review on QCD and jets for the Kyoto proceedings. In collaboration with Sterman and Collins, Mueller continued work on attempting to give quan-

titative predictions for minijet production at collider energies. Sterman also continued work on a book which will provide an introduction to perturbative field theory and a description of current methods in the study of high energy scattering. Another of Collins' projects was work on a computer program that performs the Altarelli-Parisi evolution of parton distributions (collaboration with Tung).

In other non-string activity, Niemi (with Semenoff) studied various consequences of the quantum-field-theoretic generalization of Berry's adiabatic phase, finding that global gauge anomalies can be understood in terms of induced quantum holonomy. Du worked on the phenomenology of CP invariance in the three-generation K-M model, obtaining detailed predictions for B meson decays which will provide possible CP-nonconservation signals. Adler worked on a non-standard theory of CP violation based on quaternionic quantum mechanics, finding a model which leads to superweak phenomenology arising as a second order perturbation theory effect, and predicting a threshold for new physics at or below 20 TEV. Mackenzie (with Thacker) performed the first lattice gauge theory calculation of the properties of Jaffe's proposed H-dibaryon, finding that the H particle is not stable, being massive enough to decay strongly into ordinary hadrons.

B. Astrophysics

As in previous years, Members and Visitors collaborated in a variety of different fields within astrophysics, including stellar dynamics, cosmology, interstellar matter, active galactic nuclei, planetary physics, general relativity, gravitational lenses, and dark matter.

John N. Bahcall showed how electron neutrino scattering experiments can be used to study the flavor content, spectrum shape, intensity, time dependence, and angular distribution of solar neutrinos. Detailed calculations were presented for all of the experimentally accessible distributions and for each of the important solar neutrino

sources. A number of experiments of this type are underway and should be useful in solving the solar neutrino problem, as well as exploiting solar neutrinos to learn about the physics of neutrinos. Bahcall, together with Petcov and Toshev (University of Belgrade) and Valle (University of Madrid) showed that neutrino decay could occur within the context of existing theoretical models for the combined weak and electromagnetic interactions and could explain the solar neutrino problem. Bahcall and Holstein (University of Massachusetts) calculated the detailed spectrum of neutrinos that is produced by the decay of 8 nuclei; this spectrum describes the energy distribution of the neutrinos that are most readily accessible to observation. Together with Neta A. Bahcall and Donald Schneider, Bahcall described an alternative interpretation of the wide pairs of quasars that have previously been interpreted as gravitational lenses. They suggested that the pairs are really physically different quasars in groups or clusters of galaxies; this suggestion has interesting observational consequences. Bahcall also worked with several different postdoctoral members on projects related to the distribution of stars in the Galaxy; these projects are described elsewhere in this report.

Piet Hut continued his research in stellar dynamics, where he concentrated on the dynamical evolution of globular clusters. He collaborated with: Shogo Inagaki from Kyoto University, Japan; Jun Makino from Tokyo University, Japan; Andy Fabian, Peter Eggleton and Jim Pringle from the Institute of Astronomy, Cambridge, UK; Frank Verbunt from the Max-Planck-Institut near Munich, West Germany; Haldan Cohn from Indiana University; and Herwig de Jonghe. Piet Hut entered a new area of research in the interface between Computer Science and Astrophysics. He started a long-term collaboration with Gerald Sussman, from the Artificial Intelligence Laboratory at M.I.T. This collaboration concerns the development of qualitatively new types of software, and in the future possibly new special-purpose hardware, for setting up, executing and analyzing dynamical

simulations of galaxies and star clusters. In a related project, Joshua Barnes and Piet Hut developed a novel algorithm for performing N -body calculations in which the number of interactions per particle grows only logarithmically. Another field of interdisciplinary research in which Piet Hut was active was a collaboration between four paleontologists including Erle Kauffman and William Elder (University of Colorado, Boulder), Gerta Keller (Princeton University), and Thor Hansen (Western Washington University), two geologists, Walter Alvarez (University of California, Berkeley) and Eugene Shoemaker (United States Geological Survey, Flagstaff, Arizona) and two astronomers, Paul Weissman (Jet Propulsion Laboratory, Pasadena, California) and Piet Hut. Together they wrote a comprehensive paper which addresses the possibility of comet showers causing mass extinctions, in a critical comparison of material from all three disciplines. Piet Hut and Gerta Keller were invited to give a Luis Clark Vannuxem Public Lecture at Princeton University in December 1985, in which they reported on the results of their collaboration.

Joshua Barnes worked with George Efstathiou on a project to study the generation of angular momentum by tidal torques in hierarchical clustering scenarios. A large ensemble of cosmological N -body simulations with CDM (Cold Dark Matter) fluctuation spectra were run on the Institute's VAX. Results demonstrate that the amount of angular momentum acquired by a proto-galaxy depends on several distinct uncorrelated factors, and does not exhibit the large-scale coherence from object to object required to explain, among other things, the observed relationship between density and galactic morphology in terms of a connection between angular momentum and morphology. Joshua Barnes and Piet Hut worked together to develop a new N -body algorithm, in which the long-range (e.g., gravitational) interaction of N particles may be approximately computed with only $O(N \log N)$ operations, as compared to the $O(N^2)$ required by naive algorithms. Joshua Barnes then worked to develop a parallel version of the al-

gorithm suitable for execution on a fine-grained parallel computer. A preliminary implementation of the parallel version was tested on a Connection Machine at Thinking Machines in Cambridge, MA. Joshua Barnes studied the dynamical response of a halo of dark matter when a galactic disk forms inside it. N -body models were used to simulate the halo. To obtain reasonably "flat" rotation curves requires either (1) fine-tuning of the initial halo and disk parameters, or (2) halos with a large initial core radius (comparable to the diameter of the "optical" galactic disk). Halos with large cores flatten very little in response to the disk potential, and trapping of halo mass in the disk is insignificant. The software developed for this project was also used to construct equilibrium N -body models of disk + halo galaxies, as a preliminary step in simulating encounters of realistic galaxy models.

James Binney returned to the Institute on April 3. Since then he has extended his work with S. Balbus (University of Virginia) on the stochastic acceleration of disk stars. Study of the original Spitzer-Schwarzschild diffusion process has now been completed—analytic Green functions and the corresponding similarity solutions are available for the planar problem, and the more complex diffusion coefficients for the three-dimensional problem have been evaluated. These results confirm Lacey's conclusion that the Spitzer-Schwarzschild process can explain neither the observed age-metallicity relationship nor the K-giant velocity distribution. The diffusion coefficients associated with stochastic features of any scale are now being examined. The suggestion of Carlberg & Sellwood that the epicycle amplitude ΔR and the radial wavenumber k of the exciting structure satisfy $k\Delta R, 1$ seems improbable. However, diffusion coefficients of the required form can be generated in the opposite limit $k\Delta R \gg 1$; the possibility is currently being investigated that most featureless spectra of irregularities generate the right diffusion coefficients by a central limit process. Binney's other activities have included investigation with Jeremiah P.

Ostriker (Princeton University) and P. Saha (University of Oxford) of a proposal for explaining Lauer's distribution of globular clusters in the central portion of M87, and finalization of the manuscript of *Galactic Dynamics* with Scott D. Tremaine (University of Toronto), which will be sent to Princeton University Press in the fall of 1986.

Stefano Casertano has worked in the general area of dynamics of stellar systems. Stefano Casertano, Kavan Ratnatunga and John Bahcall have produced a new program called the IAS Galaxy Model, capable of describing the stellar distribution and kinematics of the Milky Way. The program has been used to model the distribution and kinematics of the nearby bright stars in the Bright Star Catalog. Stefano Casertano and Jens Villumsen (Cal-Tech) have completed the development of a numerical code capable of describing the evolution of a three-dimensional disk galaxy. The code has been used for tests of the stability of a galaxy system including a thick disk and a stationary halo. The novel feature of these simulations is the ability to test the stabilizing effect of a finite thickness. Stefano Casertano, Piet Hut and Steve McMillan (Northwestern University) have worked at a new measurement of the relaxation time of N -body systems in numerical experiments. The method makes use of the long-term variations of the energy of individual particles. Preliminary results seem to indicate that the time scale thus defined is more akin to the evolutionary time scale of the system.

Herwig Dejonghe has explored the following topics: models for spherically symmetric star cluster, with a distribution function that depends on the two classical integrals of motion. A model is constructed that (1) uses the complete accessible phase space, (2) allows the easy calculation of the line profiles, (3) demonstrates the degeneracy of the distribution function when mass density and velocity dispersion profile is given, (4) provides an explicit and non-trivial application of the sufficient condition for radial stability as established by Antonov. Dejonghe also studied dynamical systems that enjoy a separable po-

tential: (1) Solution of the fundamental integral equation that connects the distribution function with the mass density. This solution requires a functional form for the mass density, embedded in an abstract space with a dimensionality which is two times the dimensionality of the original (physical) space. Conditions on those abstract mass densities are derived and the degeneracy of the solutions is established in the case of the elliptic disk. (2) The generalization of the Kuzmin formula (which computes the three-dimensional mass density out of a given density along one of the coordinate axes) to the infinite thin plane. An expression is derived that relates the mass density to the potential along one of the coordinate axes, but work is in progress toward a coherent picture. (3) Construction of axisymmetric models with a distribution function that explicitly depends on three integrals of the motion (with Tim de Zeeuw). An interesting connection exists with the Merritt models for spherical clusters. Dejonghe gave a critical analysis of a proof, originally given by Tolman, that the entropy of collisionless systems is steadily increasing. It is found that this proof must be interpreted carefully and is wrong in its claim for complete generality. Dejonghe has implemented a pair-regularized N -body code, based on the formulae given by Mikkola of the Heggie-generalization of the regularization algorithm of Kustaanheimo and Stiefel. It is particularly suited for calculating 3-body scatterings. Work on a code which intends to analyze statistically the Liapounov-coefficients of these dynamical systems is in progress (with Piet Hut). Realization on a supercomputer is expected.

Tim de Zeeuw's research concentrated mainly on the structure and dynamics of elliptical galaxies. He continued work on the special class of mass models for which the gravitational potential is of the so-called Stäckel form. Their general properties were delineated in collaboration with M. Franx and R. Peletier (Leiden Observatory, The Netherlands). It was shown that Stäckel models have a surprisingly large variety in shapes. A sequence of realistic triaxial Stäckel models was

found with both a very simple potential and a simple, realistic, inhomogeneous density distribution. Together with Herwig Dejonghe a new method was derived for the construction of phase-space distribution functions consistent with a given axisymmetric density. The technique was applied to the axisymmetric limits (oblate and prolate) of the sequence of models mentioned in the above. This produced—for the first time—completely analytic models with distribution functions that depend on all three integrals of motion. De Zeeuw, Martin Schwarzschild (Princeton University) and Christopher Hunter (Florida State University) completed their long study of the equilibrium models of perfect elliptic disks, and showed that these solutions are not unique. The specific model with maximum angular momentum was constructed explicitly. De Zeeuw and Scott Tremaine (Canadian Institute for Theoretical Astrophysics, Toronto, Canada) showed that the distribution function of stellar needles is unique, and universal, i.e., independent of the density distribution along the needle. Finally, de Zeeuw organized IAU Symposium No. 127, entitled *Structure and Dynamics of Elliptical Galaxies*, held at the IAS, May 28-31, 1986. About 160 astronomers from 18 countries participated.

Li-Zhi Fang studied on the following: (1) Topology of the universe. He pointed out that observational cosmology on spacetime topology of our universe is important, because it is a possible way to test the predictions of quantum cosmology. The implication on topology from observational results on quasars have been analysed. It was found that several so-called "non-cosmological phenomena" in quasars, such as periodicity in redshift distribution, close pairs, association with galaxies, seems to evidence the topologically multiple connection of cosmological space. (2) Quantum cosmology. The wavefunction of a rotating universe has been found. It was shown that the universe with large global rotation is unlikely. (3) Fractal in large scale structure. A model of a fractal string has been developed.

In particular, the relations and the values of the indexes in the observed power laws (a, correlation function; b, correlation strength with richness; c, correlation strength with separation of objects) can be explained by a cosmic string model with fractal dimension 1.4.

Jeremy Goodman continued work with P. Goldreich, R. Narayan and J. Hawley on the stability of thick accretion disks. Two-dimensional computer calculations by Hawley show that a thick accretion disk of small radial width breaks up into semi-detached blobs of fluid. Goldreich and Narayan found an exact two-dimensional solution for such blobs, and Goodman showed that the blobs are linearly stable to all orders. Papaloizou and Pringle's instability of thick disks apparently derives from the existence of this lower-energy, non-axisymmetric equilibrium. In addition, a paper by Narayan, Goldreich, and Goodman is in preparation on non-axisymmetric instabilities in an idealized system, the shearing sheet. Goodman studied gravothermal oscillations in postcollapse star clusters. He found a new type of postcollapse similarity solution having a nonsingular core and a finite total mass. Linear stability analysis shows that these solutions are unstable when the ratio of half-mass radius to core radius exceeds 50. He pointed out that many globular clusters are likely to be undergoing gravothermal oscillations and that, although they will be very centrally concentrated, their cores may be marginally resolvable. Goodman examined the possibility that the sources of gamma-ray bursts are optically thick. If so, then the sources could be extragalactic. As an exercise, he calculated the expansion of a thermal gas of photons and electron-positron pairs initially confined to a small volume and showed that the mean photon energy is conserved by the expansion. The emergent spectrum predicted by this model is harder than the observations and the burst timescale is somewhat too short, but with a time-varying energy input good agreement would be possible.

Milgrom worked on the following: (1) An

article has been written on the modified Newtonian dynamics as an alternative to dark matter. The article has been prepared for "La Recherche." (2) The use of an Eötvös-type experiment for the detection and study of possible medium-range forces had been studied. It was found that the experimental reading, in the presence of such forces, is very sensitive to topographical conditions at the experimental site. This sensitivity can be exploited to design experiments with low detection thresholds. (3) A model for the rapid-X-ray burster was proposed. The main question the model addresses is: why does the rapid burster emit bursts unlike the other X-ray sources in its class (which are similar to it in all other respects)? Other subjects which were studied, with no concrete result to report, are gravitational lenses and γ -ray bursters.

Tsvi Piran continued, with Richard Stark, to work on numerical calculations on axisymmetric rotating collapse. They have discovered numerically that there exists an upper limit, of about .001, to the efficiency of converting mass into gravitational radiation, in cases when black holes form. Piran has started to develop, with Jean-Alain Marck (Observatory of Paris at Meudon), a general (three dimensional) relativistic code. As a first stage, Piran and Marck developed a three-dimensional relativistic hydrodynamic code. With Ruth Williams (Cambridge University), Piran has developed a new formulation of three plus one Regge calculus. Using this formalism Piran and Williams have studied the evolution of a Universe coupled to a classical massive scalar field. They have shown that invariably, if the initial amplitude of the scalar field is large enough, it will evolve into an inflationary phase. With Katz and Safier (Racah Institute for Physics), Piran has found a new cylindrical family of solutions for Einstein's equations. These solutions are unique since they contain both modes of gravitational radiation.

Kavan Ratnatunga extended his objective prism survey for in-situ samples of K-giants in the outer galactic halo to the color range $0.6 <$

$(B - V) < 0.9$ using over 7500 spectra scanned on the Automated Photographic Measuring system (APM) in Cambridge, England. About 400 stars were selected for spectroscopic observation to measure line of sight velocity and estimate metal abundance. When finished this K-giant sample will constitute a complete magnitude limited sample of in-situ field halo stars with $M_V < +1$ selected with no kinematic or abundance bias. Ratnatunga (with John Bahcall and Stefano Casertano) improved the existing Galaxy star count model by developing new software to include kinematic data. Proper motion and line of sight velocity distributions can be evaluated for direct comparison with observations. The new code can also integrate over a region of sky which could be defined on a galactic or celestial coordinate system. The Yale Bright Star Catalog was modeled to compare the color distributions from a star count model over previously untested bright apparent magnitudes. Called the IAS Galaxy model, this program is both a definition and a "Software Telescope" to observe any model of our Galaxy. Astrophysical constraints will be built into the model wherever possible.

Herbert J. Rood completed work on two research projects: (1) Fifty-one (51) of the 100 compact groups in Hickson's homogeneous and complete catalog were observed in the 21-cm spectral line of neutral hydrogen, yielding 34 detections and 17 sensitive upper limits. A factor of two deficiency was discovered in the amount of neutral hydrogen in compact groups relative to loose groups (normalized to allow for differences in luminosities and morphological types of galaxies in these two types of groups) which implies that compact groups are independent dynamical entities and not transient or projected configurations in loose groups. Typically, a compact group has a luminosity (L_{CG}) and rms radial velocity dispersion equal to values for loose groups, but its radius is ≈ 20 times smaller, $M/L_{CG} \approx 3$ solar units, and dynamical friction time-scale is $\approx 2 \times 10^8$ years. Therefore if the merger of compact groups into coalescence products is a

steady state process over a Hubble time-scale, the calculated luminosity density of these merger products (number density times L_{CG}) equals twice the observed luminosity density of all galaxies, a paradoxical result [Feb. 1987 *Ap. J. Suppl.*; with B. A. Williams]. (2) A list was compiled of redshifts for 577 Abell clusters, and velocity dispersions for 77, available as of May 1986. A catalog was prepared from visual inspection of a glass copy of the Palomar Sky Survey which contains the Rood-Sastry morphological types for all 2712 Abell clusters, Hubble morphological types and separations of galaxies identified as the three brightest cluster members, and the observed number of fainter binary and triple galaxies within a Leir-van den Bergh cluster radius [March 1987 *Ap. J. Suppl.*; with M. F. Struble].

Donald Schneider, Maarten Schmidt, and James Gunn have completed two surveys for faint, high redshift ($z > 2.5$) quasars. The data were obtained using solid state detectors (CCDs) on the 5-m telescope at Palomar Mountain. The results indicate that the evolution of quasars is a spectacular one; models based on observations of nearby and moderate-redshift quasars predict that they should have found ≈ 100 objects at redshifts larger than three; they detected none! It appeared that the quasar phenomenon underwent a sudden "ignition" approximately ten billion years ago. Schneider participated in a large observational program to identify new gravitational lens systems; facilities employed in the search include the Very Large Array and the Kitt Peak 4-m and Palomar 5-m telescopes (the other collaborators were from Princeton University, MIT, and CalTech). Major results in the past year include: (1) The detection of the third image and possible primordial galaxies as well as the measurement of the redshift of the lensing mass in the $z = 3.273$ system 2016+112; (2) The discovery of two images of a $z = 1.012$ quasar separated by 2.6 arcminutes (a factor of twenty larger than that of any previously known lens); this separation implies an extremely massive ($10^{15} M_{\odot}$) lens. Donald Schneider, Alan Dressler, and

James Gunn have performed a spectroscopic and photometric investigation of a very rich, distant cluster of galaxies. The data show that galaxies in clusters have changed considerably in the past five billion years; star formation in clusters, a rare phenomenon today, was quite frequent in the relatively recent past.

Philip Solomon completed analysis of the virial mass and CO luminosity of 250 interstellar molecular clouds identified and mapped in the Massachusetts-Stony Brook CO Galactic Plane Survey. The cloud properties deduced from a numerical analysis of the three-dimensional data (galactic latitude, longitude, and velocity) led to the following conclusions (with James Barrett, R. Rivolo and Amos Yahil): (1) The Mass-luminosity relation has the form $M_{virial} \propto L_{CO}^{0.85(\pm .05)}$ over 3 orders of magnitude range in L. There is a dispersion of roughly 40% about the fit. The most massive clouds are about $5 \times 10^6 M_{\odot}$. (2) The ratio M/L derived above is in the middle of those found from other techniques such as galactic gamma rays and extinction in dark clouds. (3) The mass-luminosity relation is derived analytically from the size-linewidth relation and a model which assumes that the observed line profile intensity is a measure of the filling factor, as a function of velocity, along the line of sight. The use of the optically thick CO line to measure mass is thus explained as a consequence of the virial theorem. Philip Solomon also utilized the above data (with J. Barrett and R. Rivolo) to produce a map of the structure of the galaxy in the first quadrant showing the distribution of star forming molecular clouds. This map clearly shows spiral arm-like features extending around to the far side of the galaxy for the first time. More importantly, it shows that half of the most massive clouds in the galaxy are in one feature approximately half way between the sun and the galactic center. Solomon analyzed the relationship between molecular cloud content and far infrared luminosity of a sample of 80 galaxies chosen from the IRAS survey. He found that closely interacting and merging galaxies have

on average three times the far infrared luminosity per unit of molecular gas. The high infrared luminosity of interacting systems is interpreted as a result of an increased star formation rate within existing molecular clouds rather than an increase in the conversion of atomic to molecular gas.

Paul Weissman and Piet Hut investigated the dynamical evolution of cometary showers from the inner Oort cloud. Such showers may be a cause of biological extinction events on the earth. They showed that a typical shower had a duration of 2 to 3 Myr if caused by a random passing star penetrating the inner comet cloud, 3 to 4 Myr if caused by a close encounter of the solar system with a giant molecular cloud in the galaxy. They also showed that the temporal shape of such showers was relatively insensitive to the various physical and dynamical parameters which went into the comet Monte Carlo simulation model. In another study, Weissman and Piet Hut showed that double craters on the earth and planets could be explained by asteroids and/or comets with satellites impacting on the planets. In addition, Weissman showed that many observed cometary phenomena could be explained if one assumed that the cometary nuclei were "primordial rubble piles" of meter-sized icy conglomerate bodies, weakly bonded and subject to frequent disruption events. The primordial rubble pile concept is also supported by theoretical considerations with regard to how and where comets were likely to have formed. The concept is a modification of Whipple's original "dirty snowball" model for the cometary nucleus, which assumes nuclei are single, well-consolidated bodies.

C. Complex systems

In addition to its primary activities of particle physics and astrophysics, the School of Natural Sciences has also been supporting work on complex systems. G. Tesauro reported simulations of a non-relaxational model of convective patterns were performed

in rectangular geometrics with rigid boundary conditions and random initial conditions. States were obtained with persistent time-dependence, and the frequencies of these states were measured as a function of the control parameter and the box size. Neutral network models of classical conditioning were developed which successfully explain all behavioral phenomena seen in invertebrates. Simulations were performed using non-trivial distributed sensory representations. Equivalent circuits for the above networks were developed which utilize interneurons with modifiable thresholds, rather than modifiable synapses. Analog parallel networks were used to find exact solutions to combinatorial optimization problems in graph theory. The performance of such networks may be competitive with standard algorithms.

H. Levine, together with D. Kessler (University of Michigan) derived the scaling laws governing dendritic crystal growth in two dimensions. This analysis relied on the recently formulated methodology deriving a solvability condition via imposing constraints due to the microscopic dynamics of the growth process. The results of this calculation were verified by numerical solution of the exact steady-state evolution equations for the crystal-liquid interface. H. Levine with H. Neuberger pointed out the connection between the Fuller Lenard model used in quantum spin chains and σ models on compact manifolds such as the CP^{n-1} system. This connection shows why at $n = \infty$ there is a non-propagating phase with zero correlation length and also that for $d \geq 3$, there should be a symmetry broken phase at a small enough temperature. H. Levine together with D. Stein (Princeton University) has formulated a physico-chemical model for the phenomena of unicellular tip growth observed in a variety of biological systems. This model relies on a coupling between the calcium gradient and the cell membrane to drive pattern formation. Further analysis of this model is in progress; the hope is that the models of this sort can be used to unravel the complex coupling between ge-

netic information and physico-chemical processes that characterize all biological systems.

D. Miscellaneous

Freeman Dyson was mainly occupied with writing books. A semi-technical book with the title *Origins of Life* was published by the Cambridge University Press in January 1986. It surveys the state of knowledge and intro-

duces some new hypotheses concerning the origins of life. Another more popular book with the title *Infinite in all Directions* will be published in 1987 or 1988. It is based on a series of Gifford Lectures given in 1985 at the University of Aberdeen in Scotland. The lectures were on "Natural Theology." The book will be a collection of essays dealing with various aspects of science and technology.

The School of Natural Sciences

Permanent Member, Members with Long-term Appointments, Members and Visitors, 1985-86

In the section which follows, the information was obtained from material provided by the Members and Visitors.

Permanent Member

Julian H. Bigelow, *Applied mathematics; electronic computers; experimental physics.*

Born 1913, Nutley, New Jersey.

Massachusetts Institute of Technology, BS 1934, MS 1935.

Sperry Rand Corporation, research engineer 1936-39; IBM Corporation, research engineer 1939-41; Massachusetts Institute of Technology, research associate 1941-42, instructor 1942-43, neurosciences research program, visiting scientist 1969-70; Columbia University, OSRD, statistical research group, associate director 1943-46; Institute for Advanced Study, Electronic Computer Project, head of experimental group of 1946-51, School of Mathematics, permanent member 1951-70, School of Natural Sciences, permanent member 1970- ; University of California at Los Angeles, visiting professor 1966-67.

Members with Long-term Appointments

Michael Dine, *Elementary particle theory.*

Born 1953, Cincinnati, Ohio. The Johns Hopkins University, BS 1974; Yale University, PhD 1978.

Stanford Linear Accelerator Center, research associate 1979-80; Institute for Advanced Study, long-term member 1981- ; City College, City University of New York, associate professor 1985- .

Herman H. Goldstine, *History of computers and computation; theory of computing machines.*

Born 1913, Chicago, Illinois, University of Chicago, BS 1933, MS 1934, PhD 1936; honorary

doctorate University of Lund 1974, Amherst College 1978, Adelphi University 1978.

University of Chicago, research associate and instructor 1936-39; University of Michigan, instructor and associate professor 1939-42; US Army, in charge of development of ENIAC and of EDVAC 1942-46; IBM Corporation, research planning staff 1958, director of mathematical sciences 1958-65, consultant to director of research 1967-69, IBM Fellow 1969- ; Institute for Advanced Study, Electronic Computer Project, associate director 1946-57, School of Mathematics, permanent member 1951-58, School of Natural Sciences, member with long-term appointment 1972- , School of Historical Studies, member with long-term appointment 1977-85; Executive Officer of the American Philosophical Association 1984- .

Jeremy Goodman, *Theoretical astrophysics.*

Born 1956, Washington, D.C. Harvard University, BA 1979, MA 1979; Princeton University, PhD 1983.

California Institute of Technology, Bantrell fellow 1983-85.

Otto Neugebauer, see page 25 for biographical entry.

Tsvi Piran, *General relativity, relativistic astrophysics and numerical physics.*

Born 1949, Tel Aviv, Israel. Tel Aviv University, BS 1970, MS 1972; Hebrew University, PhD 1976.

Hebrew University, teaching assistant 1975-76, senior lecturer, 1981- ; University of Oxford, research associate, 1976-77; University of Texas, research associate 1977-79, assistant professor 1979; Institute for Advanced Study, member 1980-81, long-term member 1981- .

Donald Schneider, *Observational cosmology.*

Born 1955, Hastings, Nebraska. University of

Nebraska, BS 1976; California Institute of Technology, PhD 1982.

California Institute of Technology, research fellow 1982-85.

Andrew E. Strominger, *Quantum gravity*.

Born 1955, Cambridge, England. Harvard University, BA 1977; University of California at Berkeley, MA 1979; Massachusetts Institute of Technology, PhD 1981.

Massachusetts Institute of Technology, research assistant 1979-81; Institute for Advanced Study, member 1981-84, long-term member 1984- .

Stephen Wolfram, *Complex systems theory*.

Born 1959, London, England. California Institute of Technology, PhD 1979.

California Institute of Technology, senior research associate 1980-82; Institute for Advanced Study, long-term member 1982-86.

Tim de Zeeuw, *Theoretical astrophysics, dynamics of stellar systems*.

Born 1956, Sleen, The Netherlands. Leiden University, BSc Mathematics 1976, BSc Astronomy 1977, MSc 1980, PhD 1984.

Leiden University, teaching assistant 1977-80, research assistant 1980-84; Harvard College Observatory, research associate 1984- ; Institute for Advanced Study, long-term member 1984- .

Members

Jonathon Bagger, *Particle physics*.

Born 1955, Plainfield, New Jersey. Dartmouth College, BA 1977; Princeton University, MA 1980, PhD 1983.

Stanford Linear Accelerator Center, research associate 1983-84, physicist 1984- ; Harvard University, research associate 1985.

Joshua Barnes, *Dynamics and evolution of star clusters, galaxies, and galaxy clusters*.

Born 1956, London, England. Harvard University, BA 1979; University of California at Berkeley, PhD 1984.

Institute for Advanced Study, member 1984- .

Clifford Burgess, *Elementary particle theory*.

Born 1957, Portage la Prairie, Canada. University of Waterloo, Ontario, BSc 1980; University of Texas at Austin, PhD 1985.

Stefano Casertano, *Dynamics of galaxies and stellar systems*.

Born 1958, Naples, Italy. University of Pisa, Laurea 1979; Scuola Normale Superiore, Pisa, Diploma di Perfezionamento 1983.

Institute for Advanced Study, member 1983-86.

John Collins, *Elementary particle theory*.

Born 1949, Colchester, England. University of Cambridge, BA 1971, PhD 1975.

Princeton University, research associate 1975-76, assistant professor 1976-80; Illinois Institute of Technology, assistant professor 1980-83, associate professor 1983- .

Herwig Dejonghe, *Dynamics of stellar systems*.

Born 1957, Ronse, Belgium. University of Gent, BS 1977, MA 1979, PhD 1984.

University of Gent, teaching assistant 1979-80, research assistant 1980-85.

Dongsheng Du, *CP-violation in B^0 - \bar{B}^0 system; supersymmetry and supergravity*.

Born 1939, Hebei Province, China. Peking University, BS 1964; Institute of Atomic Energy, Beijing, PhD 1968.

Institute of High Energy Physics, Academia Sinica, research assistant 1968-77, research associate 1977-79, associate professor 1979- ; Centre Européen de la Recherche Nucléaire, visiting scholar 1978-79.

David B. Fairlie, *Mathematical physics, particle physics*.

Born 1935, South Queensferry, Scotland. University of Edinburgh, BSc 1957; University of Cambridge, PhD 1960.

University of St. Andrews, lecturer 1962-64; University of Durham, lecturer 1962-69, reader 1969- ; Centre Européen de la Recherche Nucléaire, visiting scientist 1970-71.

Carlos Galvão, *Particle physics*.

Born 1941, Natal, RN, Brazil. Universidade Federal do Rio Grande do Norte, Natal, Brazil, BS 1968; Centro Brasileiro de Pesquisas Fisicas, Brazil, MA 1974, PhD 1976.

Universidade Federal do Rio Grande do Norte, professor 1968-82; Centro Brasileiro de Pesquisas Fisicas, associate researcher 1976-82; Princeton University, visiting fellow 1979-81.

Cesar Gomez, Particle physics.

Born 1954, Madrid, Spain. Universidad Madrid, BS 1975, MA 1977; Universidad Salamanca, PhD 1980.

University of Salamanca, assistant professor 1980-81, associate professor 1983- ; Harvard University, postdoctoral fellow 1981-83.

Han-Ying Guo, Particle physics, relativity.

Born 1939, Zhongqing, Sichuan, China. Qing Hua University, Beijing, China, BS 1964.

Institute of High Energy Physics, Academia Sinica, associate research professor 1978- ; Kyoto University, visiting research fellow 1983-84; Institute of Theoretical Physics, State University of New York at Stony Brook, visiting research professor 1985.

Antal Jevicki, Particle physics.

Born 1951, Subotica, Yugoslavia. University of Belgrade, BS 1972; City University of New York, MA 1973, PhD 1976.

City University of New York, research assistant 1972-76; Institute for Advanced Study, member 1976-79; Brown University, assistant professor 1973-81, associate professor 1981- ; Institute of Theoretical Physics, University of California at Santa Barbara, visiting member 1981; Ecole Normale Supérieure, visiting professor 1984.

Jose Labastida, Theoretical physics.

Born 1958, Madrid, Spain. Universidad Autónoma de Madrid, Licenciatura 1980; State University of New York at Stony Brook, MA 1984, PhD 1985.

Paul Mackenzie, Elementary particle theory.

Born 1950, Oak Park, Illinois. University of Illinois at Urbana, BS 1975; Cornell University, MS 1977, PhD 1981.

Fermi National Accelerator Laboratory, research associate 1981-84; Institute for Advanced Study, member 1984-86.

Corrine Manogue, Field theory in curved spacetime.

Born 1955, Cincinnati, Ohio. Mount Holyoke College, BA 1977; University of Texas at Austin, PhD 1984.

Timothy R. Morris, Particle physics.

Born 1960, Birmingham, England. University of Cambridge, BS 1982; University of Southampton, PhD 1985.

Alfred Mueller, Particle Physics.

Born 1939, Chicago, Illinois. Iowa State University, BS 1961; Massachusetts Institute of Technology, PhD 1965.

Columbia University, associate professor 1972-74, professor 1974- .

Mark Mueller, Superstrings: global

*reparameterization anomalies in Type I
superstrings.*

Born 1956, Milwaukee, Wisconsin. Massachusetts Institute of Technology, BS 1978; Stanford University, PhD 1984.

Institute for Advanced Study, member 1984- .

Antti J. Niemi, Quantum field theory.

Born 1956, Helsinki, Finland. Helsinki University of Technology, BSc 1979, MSc 1980; Massachusetts Institute of Technology, PhD 1983.

Institute for Advanced Study, member 1983-86.

Norman Packard, Complex systems theory.

Born 1954, Billings, Montana. Reed College, BA 1976; University of California at Santa Cruz, PhD 1982.

Institut des Hautes Etudes Scientifiques, member 1982-83; Institute for Advanced Study, member 1983-86.

Zongan Qiu, Particle physics.

Born 1960, Zhengzhou, Henan, China. University of Zhengzhou, BS 1981; University of Chicago, PhD 1985.

**Kavan U. Ratnatunga, Study of K-giants in the outer
galactic halo.**

Born 1952, Colombo, Sri Lanka. University of Ceylon, Colombo, Sri Lanka, BSc 1976; University of Pittsburgh, MS 1979; Australian National University, Canberra, Australia, PhD 1983.

University of Sri Lanka, Colombo, lecturer 1976-78; University of Pittsburgh, teaching assistant 1978-79; Institute for Advanced Study, member 1983-86.

Hai-cang Ren, Stochastic quantization,

supersymmetry, string theory.

Born 1956, Beijing, People's Republic of China. Columbia University, MA 1981, MPh 1983, PhD 1984.

Institute for Advanced Study, member 1984-86.

Robert S. Shaw, Jr., *Dynamical systems*.

Born 1946, Boston, Massachusetts. Harvard College, BA 1972; University of California at Santa Cruz, PhD 1980.

University of Texas at Austin, consultant 1980-81; University of California at Santa Cruz, assistant professor 1982-83; Institute for Advanced Study, member 1984-86.

Mordechai Spiegelglas, *Particle physics*.

Born 1955, Tel Aviv, Israel. Tel Aviv University, BSc 1974, MSc 1979, PhD 1985.

Tel Aviv University, instructor 1983-85.

George Sterman, *Perturbative quantum chromodynamics*.

Born 1946, Washington, D.C. University of Chicago, BA 1968; University of Maryland, PhD 1974.

University of Illinois, research associate 1974-76; State University of New York at Stony Brook, research associate 1976-78, assistant professor 1979-84, associate professor 1984- ; Institute for Advanced Study, member 1978-79.

Gerald J. Tesauro, *Complex systems theory*.

Born 1959, Washington, D.C. University of Maryland, BS 1980; Princeton University, PhD 1985.

Visitors**James Binney**, *Stellar dynamics*.

Born 1950, London, England. University of Cambridge, MA 1974; University of Oxford, DPhil 1976.

Princeton University, assistant professor 1979-81; University of Oxford, lecturer 1981- ; Institute for Advanced Study, visitor 1984- .

Ewine van Dishoeck, *Molecular astrophysics*.

Born 1955, Leiden, The Netherlands. University of Leiden, BS (chemistry) 1976, (mathematics) 1977, MA 1980, PhD 1984.

Harvard University, research assistant 1980, junior fellow 1984-87; Leiden Observatory, research assistant 1980-84; Institute for Advanced Study, visitor 1984- .

Li-Zhi Fang, *Theoretical astrophysics*.

Born 1936, Zhejiang, China. Peking University, graduate from department of physics 1956.

University of Science and Technology of China, professor 1978- ; Institute for Fundamental Physics, University of Kyoto, visiting professor 1981-82.

George Lake, *Galaxy formation and clustering*.

Born 1953, Washington, D.C. Haverford College, BA 1975; Princeton University, MA 1976, PhD 1980.

University of California at Berkeley, research astronomer 1979-81; Institute of Astronomy, University of Cambridge, fellow, Churchill College 1980-81; Bell Laboratories, member of technical staff 1981- ; Institute for Advanced Study, member 1984- .

Mordehai Milgrom, *Theoretical astrophysics*.

Born 1946, Iasi, Rumania. Hebrew University, BSc 1966; Weizmann Institute, MSc 1968, PhD 1972.

Weizmann Institute, researcher 1974-76, senior researcher 1976-79, associate professor 1979-83, professor 1983- ; Cornell University, research associate 1972-74; Institute for Advanced Study, member 1980-81.

Bohdan Paczynski, *Astrophysics*.

Born 1940, Wilno, Poland. Warsaw University, Poland, MA 1962, PhD 1964, Docent 1967.

Warsaw University Observatory, assistant 1959-62; Lick Observatory, University of California, assistant 1962-63; Polish Academy of Science, research assistant 1964-67, assistant to associate professor 1968-78, professor 1978-82; Institute for Advanced Study, visitor 1974- ; Princeton University, professor 1982- .

Martin J. Rees, *Astrophysics*.

Born 1942, York, United Kingdom. Trinity College, University of Cambridge, BA 1963, PhD 1967.

California Institute of Technology, research fellow 1968, visiting associate professor 1971; Jesus College, University of Cambridge, fellow 1967-69; Institute of Theoretical Astronomy, University of Cambridge, staff member 1967-72, professor 1973- , director 1977-82; Institute for Advanced Study, member 1969-70, visitor 1984- ; King's College, University of Cambridge, senior research fellow 1969-72, professorial fellow 1973- ; Harvard University, visiting professor 1972; Sussex University, professor 1972-73.

Herbert J. Rood, *Structure of systems of galaxies.*

Born 1937, New Brunswick, New Jersey. Massachusetts Institute of Technology, BS 1959; University of Michigan, MS 1961, PhD 1965.

Wesleyan University, assistant professor 1965-72; Institute for Advanced Study, member 1972-73, visitor 1980- .; Michigan State University, associate professor 1973-76, associate adjunct professor 1980-82.

Gordon Semenoff, *Quantum field theory.*

Born 1953, Pincher Creek, Alberta, Canada. University of Alberta, BS 1976, PhD 1981.

University of Alberta, postdoctoral fellow and lecturer 1981-82; Massachusetts Institute of Technology, postdoctoral fellow 1982-83; University of British Columbia, research fellow 1983- .; Institute for Advanced Study, visitor 1984- .

Robert Wagoner, *Astrophysics.*

Born 1938, Teaneck, New Jersey. Cornell University, BME 1961; Stanford University, MS 1962, PhD 1965.

California Institute of Technology, research fellow 1965-68, Sherman Fairchild distinguished

scholar winter 1976; Institute of Theoretical Astronomy, University of Cambridge, visiting fellow summer 1967 and July 1971; Cornell University, assistant professor 1968-71, associate professor 1971-73; Stanford University, associate professor 1973-77, professor 1977- .; Enrico Fermi Institute, University of Chicago, visiting professor fall 1978.

Paul Weissman, *Planetary physics and dynamics.*

Born 1947, Brooklyn, New York. Cornell University, BA 1969; University of Massachusetts, MS 1971; University of California at Los Angeles, PhD 1978.

Jet Propulsion Laboratory, California Institute of Technology, senior scientist 1974- .

Louis Witten, *General relativity.*

Born 1921, Baltimore, Maryland. The Johns Hopkins University, BE 1941, PhD 1951.

Princeton University, research associate 1951-52; University of Maryland, research associate 1952-54; Massachusetts Institute of Technology, research associate 1954-55; Martin Marietta Research Laboratory, associate director 1955-68; University of Cincinnati, professor 1968- .

The School of Social Science

Faculty

Clifford Geertz

(Harold F. Linder Professor of Social Science)

Joan Wallach Scott

Michael Walzer

(1907 Foundation Professor)

Professor Emeritus

Albert O. Hirschman

Member with Long-term Appointment

Bernard Lewis

The School of Social Science

In terms of its formal existence, the School of Social Science is the youngest of the Institute's four divisions. Although its roots go back to 1935 to what was then the School of Economics and Politics at the Institute, its creation as an enduring program came with a permanent academic appointment in 1970-71 and its formulation as a School in 1973. This process of moving from program to School, from experimental venture to institutionalization, is an essential characteristic of growth at the Institute.

The School of Social Science pursues an operational pattern parallel to that of other Institute Schools, combining a rather small number of permanent Faculty with a larger group of visiting annual members drawn from an ever wider pool of candidates.

The School of Social Science does not normally attempt to take on large-scale statistical or quantitative studies. Such work has been done at the Institute, but it is not central to its purpose. Furthermore, the School does not select certain social problems and, seeking their solutions, come up with prescriptions for this or that social malaise. This does not mean that such uses may not be made of work accomplished at the Institute. Indeed, an interest in policy questions has characterized the work of some members of the School and will surely do so in the future. However, the main focus of the School is interpretive in nature, investigating the meanings of social behavior and delineating the determinants of social change. As such it is resolutely multidisciplinary, cross-cultural and internationally comparative, drawing its data from historical as well as contemporary problems, exploiting ethnographic as well as quantitative sources.

In a sense, the empirical findings of the social sciences are employed to criticize and to refine both methodology and theory in the contemporary human sciences. Thus the School, while giving credit to the long dominant quantitative approach in American social science, nevertheless shares in the growing numbers of reservations expressed about it, that is, that its methods are narrow and overspecialized, that its procedures lead to a warping present-mindedness and that both combine to create an unjustified scientism, incapable of producing a legitimate, durable set of solutions to the pressing social and economic problems of our time.

This intellectual posture demonstrates one of the roles of the Institute for Advanced Study as part of the seamless fabric of higher education and research—to use, when warranted, its private security and intellectual freedom for an independent position in, and critical assessment of, the academic accomplishment embraced by its areas of expertise.

Academic Activities, 1985-86

During 1985-86, the School of Social Science had fifteen Visiting Members and two Visitors. Professor Clifford Geertz was on sabbatical leave, doing fieldwork in Morocco and Indonesia. Bernard Lewis, who had a shared long-term appointment as a Visiting Member with the School of Historical Studies, retired in June, 1986.

The Thursday Luncheon Seminars were well attended, not only by the Members of the School but by colleagues from Historical Studies and members of the Princeton academic community. The list of topics can be seen in the Record of Events. Four of the seminars

were given by Visiting Members of the School of Historical Studies and three by guests from other institutions; the other nineteen were given by Members and Visitors of the School of Social Science. The range of issues discussed was wide, as usual.

The core group among the Visiting Members consisted of six scholars who studied the social experience of equality and inequality. Given the situated individual, how does he understand justice, what are his encounters with injustice, and how is a particular society structured to deal with such understandings and encounters? How does hierarchy work, and how is it generated, resisted and defended? A seminar on inequality was organized and met regularly every two weeks throughout the year.

Another group, consisting of economists, met every week during the first term and bi-weekly during the second term. They discussed their work in progress as well as other work and, during the second term, jointly wrote a paper to be published this year, "The Growth and Decay of Custom: The Role of the New Institutional Economics in Economic History."

The third seminar which met every other week discussed the uses of gender as a category of social scientific analysis. The participants in this seminar came from the greater Princeton academic community as well as the Institute. The areas and interests of the participants provided a varied background for these discussions.

Planning Activities

The permanent members of the Faculty (Professors Scott and Walzer with the assistance of Professor Hirschman) met in December and January to make membership application decisions for the 1986-87 year. They consulted by mail with Professor Geertz.

In a separate competition for a German fellow of junior university rank, sponsored by the Volkswagen Foundation, Dr. Wolf Lepenies, a former Long-term Visiting Member,

served as an advisory consultant. This was the second year of that competition.

In all, two hundred thirty applications were read. Outside referees were asked to evaluate and rank the most promising applicants.

The theme for the 1986-87 year will be interpretation of hermeneutic and epistemological problems in the social sciences; six Members of the School will form the center of the study group. This coming year's project is the third part of a three-year program on "interpretive social science." The first year focused on life histories as a tool of sociological research and the second year, on inequality and hierarchy.

Funding

During the 1985-86 academic year two members of the core program in interpretive social science were supported by a grant from The Henry Luce Foundation. Another six members were supported, wholly or in part, by the National Endowment for the Humanities. The Exxon Research and Engineering Company also supported one fellow.

Faculty

Clifford Geertz was on sabbatical for 1985-86. He spent the first portion of it in Paris preparing his Tanner Lecture, "The Uses of Diversity," given at the University of Michigan in November. From November to March, he was in a small town in Morocco doing field work; from March to September he was in a small town in Indonesia to the same end.

Professor Joan Scott joined the Institute Faculty in the fall. She devoted much of her time to writing a series of essays on gender and history that will be published next year. An essay called "Women's History as Women's Education" was published by Smith College in 1986; another essay "Statistical Representations of Work: The Chamber of Commerce's *Statistique de l'Industrie à Paris, 1847-48*," was published in S. Kaplan and

C. Koepp, eds., *Work in 18th and 19th Century France* by Cornell University Press. Professor Scott also delivered a paper at the American Historical Association meeting in December on "Gender: A Useful Category of Historical Analysis." She lectured as a Visiting Distinguished Scholar at New York University in April, 1986. In July, she gave a paper at a conference on "Feminism and the Humanities" at the Humanities Research Center of the Australian National University (Canberra).

Professor Michael Walzer delivered the Director's Lecture at the Institute in the fall of 1985, on "Commitment and Social Criticism: Camus' Algerian War." In November he gave a set of Tanner Lectures at Harvard, to be published by the Harvard University Press under the title *Interpretation and Social Criticism*. In the course of the year, he also lectured at Rutgers University, University of Pennsylvania, University of North Carolina, West Point, Dartmouth College, and in New York City at Hunter College, Columbia University, Pace University and Baruch College. He continued to work on a book dealing with the practice of social criticism, to which his Tanner Lectures are a kind of philosophical preface. He wrote

an introduction to a new edition of Isaiah Berlin's *The Hedgehog and the Fox* (Simon and Schuster, 1986). For a fifth year, he served on the committee of scholars working to rebuild the graduate faculty of the New School for Social Research.

Professor Emeritus Albert O. Hirschman published "On Democracy in Latin America" in the *New York Review of Books*, and "In difesa del possibilismo" ("In Defense of Possibilism") in *I limiti della democrazia*, a book of essays in memory of Gino Germani. *The Passions and the Interests* was published in a Japanese translation and *Getting Ahead Collectively* in Spanish. He attended conferences in São Paulo, Vienna, and Caracas, and was an active member of the Executive Panel of the Ford Foundation Project on Social Welfare Policy and of the committee on States and Social Structures of the Social Science Research Council. He was elected a foreign member of the Accademia Nazionale dei Lincei and received an honorary doctor of science degree from the University of Southern California, Los Angeles. In April and May he travelled in Brazil, Argentina, Chile and Mexico for research.

The School of Social Science

Member with Long-term Appointment, Members and Visitors, 1985-86

In the section which follows, the information was obtained from material provided by the Members and Visitors.

Member with Long-term Appointment

Bernard Lewis, *Islamic history*.

Born 1916, London, England. University of London, BA 1936; University of Paris, Diplôme des Etudes Sémitiques 1937; University of London, PhD 1939; honorary doctorate Hebrew University 1974, Tel Aviv University 1979.

University of London, School of Oriental and African Studies, assistant lecturer in Islamic history 1938, lecturer 1940, senior lecturer 1946, reader 1947, professor of the history of the Near and Middle East 1949-74; University of California at Los Angeles, visiting professor 1955-56; Columbia University, visiting professor 1960; Indiana University, visiting professor 1963; Princeton University, visiting professor 1964, Cleveland E. Dodge Professor of Near Eastern Studies 1974- ; Institute for Advanced Study, member 1969, member with long-term appointment 1974- .

Members

Jeffrey C. Alexander, *Watergate and the crisis of civil society*.

Born 1947, Milwaukee, Wisconsin. Harvard University, BA 1969; University of California at Berkeley, PhD 1978.

University of California at Berkeley, lecturer 1974-76; University of California at Los Angeles, assistant professor 1976-81, professor 1981- .

Robert Amdur, *The theory of freedom of expression*.

Born 1945, Brooklyn, New York. Princeton University, BA 1966; Harvard University, PhD 1975.

Columbia University, lecturer 1974-75, assistant professor 1981- ; Harvard University, assistant professor 1975-80.

Kaushik Basu, *Power and inequality: industrial organization theory*.

Born 1952, Calcutta, India. St. Stephen's College, Delhi University, BA 1972; London School of Economics, MSc 1974, PhD 1976.

University of Reading, lecturer 1976-77; Delhi School of Economics, reader 1978-85, professor 1985- ; Catholic University of Louvain, Louvain-la-Neuve, Belgium, visiting associate professor 1981-82; Center for Mathematical Economics, Brussels, visiting professor 1981-82.

Franco Ferraresi, *The radical right: conservatism, traditionalism, violence*.

Born 1940, Cremona, Italy. Catholic University, Milan, LLD 1963; University of Rome, Libera Docenza 1972.

Catholic University, Milan, lecturer 1970-74; University of Trent, lecturer 1970-74; University of Calabria, Cosenza, lecturer 1975-76; University of Turin, professor 1976- , deputy chancellor 1984- ; Ecole des Hautes Etudes en Sciences Sociales, Paris, directeur d'études adjoint 1985.

Christopher Jencks, *Income inequality and economic efficiency*.

Born 1936, Baltimore, Maryland. Harvard University, BA 1958, MFA 1959.

Institute for Policy Studies, Washington,

D.C., fellow 1963-67; Harvard University, lecturer to professor 1967-79; Northwestern University, professor 1979- .

Eric L. Jones, *Global historical pattern of economic growth*.

Born 1936, Andover, Hampshire, England. University of Nottingham, BA 1958; University of Oxford, MA 1964, DPhil 1962, DLitt 1985.

Nuffield College, University of Oxford, research fellow 1963-67; University of Reading, lecturer 1967-70; Northwestern University, professor 1970-75; La Trobe University, professor 1975- .

Andrew Levine, *Studies in the political theories of Rousseau and Marx*.

Born 1944, Philadelphia, Pennsylvania. Columbia University, BA 1966, PhD 1971.

University of British Columbia, assistant professor 1971-74; University of Wisconsin at Madison, assistant professor 1974-78, associate professor 1978-84; professor 1984- .

Glenn C. Loury, *Social structure and group economic inequality*.

Born 1948, Chicago, Illinois. Northwestern University, BA 1972; Massachusetts Institute of Technology, PhD 1976.

Northwestern University, assistant professor 1976-79; University of Michigan, associate professor 1979-80, professor 1980-82; Harvard University, professor 1982- .

Bernard Manin, *The concept of public opinion in political theory*.

Born 1951, Marseille, France. Ecole Normale Supérieure, Agrégation de Philosophie 1973.

Ecole Normal Supérieure, Reims, professor 1977-82; Centre National de la Recherche Scientifique, research assistant 1982- .

Jane J. Mansbridge, *Envy and equality*.

Born 1939, New York, New York. Wellesley College, BA 1961; Harvard University, MA 1966, PhD 1971.

University of Chicago, assistant professor 1973-80; Northwestern University, associate professor 1980- .

Heiner Meulemann, *Life planning, life career, and inequality*.

Born 1944, Woerth, Bavaria, Germany.

University of Frankfurt, Diplom-Soziologe 1971, DrPhil 1974, Habilitation 1983.

University of Frankfurt, assistant professor 1971-75, visiting professor 1983-85; University of Cologne, assistant professor 1975- ; University of Duisburg, visiting professor 1981-82.

István Rév, *Economic resistance and survival techniques in highly centralized societies*.

Born 1951, Budapest, Hungary. Eotvos Lorand University, Diploma 1975; Karl Marx University of Economics, Diploma 1983.

Hungarian Academy, assistant research fellow 1975-77; Karl Marx University, Budapest, assistant research fellow 1977-79, scientific research fellow 1979-81; East-Central European Research Center, Budapest, scientific research fellow 1981- .

Ekkehart Schlicht, *The firm as a shelter*:

psychological foundations of the labor contract.

Born 1945, Kiel, West Germany. University of Regensburg, Diplom-Volkswirt 1969, DrRerPol 1971.

University of Bonn, visiting scholar 1975-76; University of Bielefeld, professor 1976-80; Darmstadt Institute of Technology, professor 1980- .

Carmen J. Sirianni, *Of time, work and equality*.

Born 1947, Brooklyn, New York. Manhattan College, BA 1969; New School for Social Research, MA 1972; State University of New York at Binghamton, PhD 1979.

Brandeis University, visiting assistant professor 1979-81; Northeastern University, assistant professor 1981- .

Joan E. Vincent, *The social history of County Fermanagh, Ireland, 1800 to the present*.

Born 1928, Camberley, England. London School of Economics, BSc 1957; University of Chicago, MA 1964; Columbia University, PhD 1968.

Teacher Training College, Zanzibar, lecturer 1958-63; Makerere University College, Kampala, Uganda, lecturer 1966-67; Barnard College, Columbia University, assistant professor to professor 1968- .

Visitors

Ruth Bloch, *Early American marriage, 1630-1830.*

Born 1949, Palo Alto, California. University of California at Berkeley, BA 1972, MA 1973, PhD 1980.

University of California at Los Angeles, visiting assistant professor 1980-82, assistant professor 1982- .

Anna Elisabetta Galeotti, *Methodological*

individualism and political individualism.

Born 1953, Bergamo, Italy. University of Pavia, Laurea 1975.

University of Pavia, research assistant 1975-78; Fondazione Feltrinelli Milano, research member 1978-81; University of Cambridge, visiting scholar 1981-83; University of Messina, assistant professor 1985- .

Record of Events, 1985-86

The following events of interest to the Institute community took place between July 1, 1985, and June 30, 1986. Not all meetings, such as some of the more informal seminars are recorded, but what follows indicates the variety and quality of Institute activities.

September 24

School of Mathematics

D-Modules and Representations of Reductive Groups:
"Introductory survey"
Dragan Milićić, University of Utah; Visiting Member, School of Mathematics, IAS

September 30

School of Mathematics

Dynamical Systems Seminar: "Attractors for homeomorphisms of the disk"
Ittai Kan, University of Michigan; Visiting Member, School of Mathematics, IAS

Members' Seminar: "Analytic methods for diophantine problems"

Wolfgang Schmidt, University of Colorado; Visiting Member, School of Mathematics, IAS

October 1

School of Mathematics

D-Modules and Representations of Reductive Groups: "Formal properties of the localization functor"
Dragan Milićić, University of Utah; Visiting Member, School of Mathematics, IAS

October 3

School of Historical Studies

Art History Colloquia: "Las ventes Uhde-Kahnweiler 1921-1923: La fin d'une avant-garde cubiste"
Christian Derouet, Musée National d'Art Moderne; Visiting Member, School of Historical Studies, IAS

School of Mathematics

Topology Seminar: "Cohomology of the variety of complete quadrics"
Robert D. MacPherson, Brown University, Visiting Member, School of Mathematics, IAS

70 Record of Events

	Transcendental and Analytic Number Theory: "Introduction to algebraic independence, I" Michel Waldschmidt, Institut Henri Poincaré, Visiting Member, School of Mathematics, IAS
October 4 School of Natural Sciences	Theoretical Physics Seminar: "Moderately excited dynamical systems" Guest Lecturer: David Ruelle, Rutgers University and Institut des Hautes Etudes Scientifiques
October 7 School of Mathematics	Dynamical Systems Seminar: "Resonances for dynamical systems and an extension of the concept of Gibbs states" Guest Lecturer: David Ruelle, Rutgers University and Institut des Hautes Etudes Scientifiques
October 8 School of Mathematics	D-Modules and Representations of Reductive Groups: "Review of D-modules" Armand Borel, Professor, School of Mathematics, IAS
	Transcendental and Analytic Number Theory: "Introduction to algebraic independence, II" Patrice Philippon, Harvard University; Visiting Member, School of Mathematics, IAS
October 10 School of Mathematics	Transcendental and Analytic Number Theory: "Limits of the method of exponent pairs" Guest Lecturer: Sidney W. Graham, Michigan Technological University
	Special Lecture: "Introduction to simple strings for non-physicists" Guest Lecturer: Edward Witten, Princeton University
School of Social Science	Social Science Luncheon Seminar: "Ignazio Silone and the Communist Party" Michael Walzer, Professor, School of Social Science, IAS
October 14 School of Mathematics	Dynamical Systems Seminar: "Renormalization for non-autonomous mappings of the interval and circle" Guest Lecturer: Pierre Collet, Rutgers University and Centre National de la Recherche Scientifique, Palaiseau
	Members' Seminar: "Perambulation in the symplectic group" Nancy Hingston, University of Pennsylvania; Visiting Member, School of Mathematics, IAS
School of Natural Sciences	Monday Lunchtime Seminar: "An off-shell propagator for string theory" Guest Lecturer: Gregory Moore, Harvard University

October 15

School of Mathematics

D-Modules and Representations of Reductive Groups: "Review of D-modules" (continued); and "Orbits on flag varieties"
Armand Borel, Professor, School of Mathematics, IAS

School of Social Science

Economics Seminar: "Discussion of Maurice Godelier's *Rationality and Irrationality in Economics*"

October 17

School of Mathematics

Special Lecture: "Introduction to simple strings for non-physicists" (continued)
Guest Lecturer: Edward Witten, Princeton University

Topology Seminar: "Differential graded Clifford algebras and fiber squares"

Johannes Huebschmann, Mathematische Institut, Heidelberg; Visiting Member, School of Mathematics, IAS

Transcendental and Analytic Number Theory: "Introduction to Chow-Nesterenko forms"

W. Dale Brownawell, Pennsylvania State University; Visiting Member, School of Mathematics, IAS

School of Social Science

Social Science Luncheon Seminar: "How we lost the equal rights amendment"

Jane Mansbridge, Northwestern University; Visiting Member, School of Social Science, IAS

October 18

School of Natural Sciences

Theoretical Physics Seminar: "Taking a hard look at perturbation theory"

Guest Lecturer: Adrian Patrascioiu, Los Alamos National Laboratory

October 21

School of Mathematics

Dynamical Systems Seminar: " ω -limit sets for maps of the interval"

Ethan Coven, Wesleyan University; Visiting Member, School of Mathematics, IAS

Members' Seminar: "Three easy counterexamples in algebraic geometry"

Madhav V. Nori, Tata Institute of Fundamental Research; Visiting Member, School of Mathematics, IAS

School of Social Science

Inequality Seminar: "The meanings of equal opportunity"
Christopher Jencks, Northwestern University; Visiting Member, School of Social Science, IAS

October 22

School of Mathematics

D-Modules and Representations of Reductive Groups: "Geometric classification of irreducible Harish-Chandra modules"

Dragan Milićić, University of Utah; Visiting Member, School of Mathematics, IAS

72 Record of Events

	Transcendental and Analytic Number Theory: "The order of the Riemann zeta function on the critical line" Henryk Iwaniec, Polish Academy of Sciences; Visiting Member, School of Mathematics, IAS; and "A mean value theorem for certain exponential sums" Enrico Bombieri, Professor, School of Mathematics, IAS
School of Natural Sciences	Informal Seminar on Superstrings: "2-D conformal field and string theory" Zong-An Qiu, University of Chicago; Visiting Member, School of Natural Sciences, IAS
School of Social Science	Economics Seminar: "Cognitive dissonance in Economics" Ekkehart Schlicht, University of Mannheim; Visiting Member, School of Social Science, IAS
	Gender Seminar: "Binary Thinking"
October 23	
School of Natural Sciences	Theoretical Physics Seminar: "Chiral symmetry, chiral anomaly, and incommensurate charge density waves" Guest Lecturer: Zhao-Bin Su, City College of New York and Academia Sinica, Beijing
October 24	
School of Mathematics	Special Lecture: "Introduction to simple strings for non-physicists" (continued) Guest Lecturer: Edward Witten, Princeton University
	Topology Seminar: "Decomposition of classifying spaces of abelian p-groups" Guest Lecturer: Nicholas Kuhn, Princeton University
	Transcendental and Analytic Number Theory: "Introduction to Chow-Nesterenko forms" (continued) W. Dale Brownawell, Pennsylvania State University; Visiting Member, School of Mathematics, IAS
School of Social Science	Social Science Luncheon Seminar: "Can virtue be taught?" Guest Lecturer: Amy Gutmann, Princeton University
October 25	
School of Natural Sciences	Theoretical Physics Seminars: "The monster: the ultimate symmetry of nature" Guest Lecturer: George Chapline, Lawrence-Livermore Laboratory and University of California
Director's Lecture	"Commitment and social criticism: Camus' Algerian war" Michael Walzer, Professor, School of Social Science, IAS

October 28

School of Mathematics

Dynamical Systems Seminar: "The complex Hénon mapping"
 Guest Lecturer: John Hubbard, Cornell University

Members' Seminar: "Schottky's problem"
 Bert van Geemen, State University of Utrecht; Visiting Member,
 School of Mathematics, IAS

School of Natural Sciences

Monday Lunchtime Seminar: "Radiation amplitude zeros—a test
 of gauge theory"
 Guest Lecturer: Mark Samuel, Oklahoma State University,
 Stillwater

October 29

School of Mathematics

D-Modules and Representations of Reductive Groups: "Review
 of regular holonomic modules and Riemann-Hilbert
 correspondence"
 Armand Borel, Professor, School of Mathematics, IAS

October 31

School of Mathematics

Special Lecture: "Introduction to simple strings for non-
 physicists" (continued)
 Guest Lecturer: Edward Witten, Princeton University

Topology Seminar: "Differential graded Clifford algebras and
 fiber squares"
 Johannes Huebschmann, Mathematische Institut, Heidelberg;
 Visiting Member, School of Mathematics, IAS

Transcendental and Analytic Number Theory: "Algebraic
 independence criterion, I'"
 Patrice Philippon, Harvard University; Visiting Member, School
 of Mathematics, IAS

School of Social Science

Social Science Luncheon Seminar: "Exit and voice: one more
 time"
 Albert O. Hirschman, Professor Emeritus, School of Social
 Science, IAS

November 1

School of Natural Sciences

Theoretical Physics Seminars: "Quantum Cosmology"
 Guest Lecturer: Alex Vilenkin, Tufts University

November 4

School of Mathematics

Members' Seminar: "Homology of the complement of a
 collection of affine subspaces of Euclidean space"
 Robert Mark Goresky, Northeastern University; Visiting
 Member, School of Mathematics, IAS

School of Social Science

Inequality Seminar: "Julius Evola: at the crossroad between
 classical reactionary thought and contemporary right
 radicalism"

Franco Ferraresi, University of Turin; Visiting Member, School of
 Social Science, IAS

November 5

School of Mathematics

D-Modules and Representations of Reductive Groups: "Proof of the Kazhdan-Lusztig conjecture"
Joseph N. Bernstein, Harvard University; Visiting Member, School of Mathematics, IAS

Transcendental and Analytic Number Theory: "A cubic Shimura correspondence on $GL(3)$ "
Daniel Bump, University of Texas, Austin; Visiting Member, School of Mathematics, IAS; and Jeffrey Hoffstein, University of Rochester; Visiting Member, School of Mathematics, IAS

School of Natural Sciences

Informal Seminar on Superstrings: "Conformal algebra and the Polyakov string"
Guest Lecturer: Emil Martinec, Princeton University

November 7

School of Historical Studies

Art History Colloquia: "Devotion and planning in a Florentine new town of the fourteenth century"
David Friedman, Massachusetts Institute of Technology; Visiting Member, School of Historical Studies, IAS

School of Social Science

Social Science Luncheon Seminar: "The two Tocquevilles, father and son: Hervé and Alexis de Tocqueville on the coming of the French Revolution"
Robert Palmer, Princeton University; Visitor, School of Historical Studies, IAS

School of Mathematics

Topology Seminar: "Circle actions on spin manifolds and elliptic integrals"
Guest Lecturer: Peter Landweber, Rutgers University

Transcendental and Analytic Number Theory: "Algebraic independence criterion, II"
Patrice Philippon, Harvard University; Visiting Member, School of Mathematics, IAS

November 8

School of Natural Sciences

Theoretical Physics Seminar: "Ashkin-Teller and Gross-Neveu models: new relations and results, I"
Guest Lecturer: Ramamurti Shankar, Yale University

November 11

School of Mathematics

Dynamical Systems Seminar: "Existence of point eigenvalues for the one dimensional quasi-periodic Schrödinger equation"
Guest Lecturer: Michel Herman, Princeton University and Ecole Polytechnique, Palaiseau

Members' Seminar: "Adduced representations of general linear groups"
Siddhartha Sahi, Yale University; Visiting Member, School of Mathematics, IAS

School of Natural Sciences

Monday Lunchtime Seminar: "Quantum holonomy and gauge algebras—can anomalous theories be quantized?"
Antti Niemi, Visiting Member, School of Natural Sciences, IAS

November 12

School of Mathematics

D-Modules and Representations of Reductive Groups: "Review of 'classical' classification of irreducible Harish-Chandra modules"
Dragan Milićić, University of Utah; Visiting Member, School of Mathematics, IAS

Diophantine Approximation: "The number of solutions of Thue equation"

Enrico Bombieri, Professor, School of Mathematics, IAS

School of Social Science

Gender Seminar: "Analyses of sexual symbolism—some examples"

November 13

School of Mathematics

Special Lecture: "Extended automorphic forms and the volume formula of Langlands"
Guest Lecturer: William Casselman, University of British Columbia

School of Natural Sciences

Informal Seminar on Superstrings: "Bootstrap and 2-dimensional conformal field theory"
Zong-An Qiu, University of Chicago; Visiting Member, School of Natural Sciences, IAS

November 14

School of Mathematics

Special Lecture: "Introduction to simple strings for non-physicists" (continued)
Guest Lecturer: Edward Witten, Princeton University

Topology Seminar: "Doubly sliced knots and double disc knots"
Guest Lecturer: Lawrence Smolinsky, Yale University

Transcendental and Analytic Number Theory: "Algebraic independence criterion, III"

Patrice Philippon, Harvard University; Visiting Member, School of Mathematics, IAS

School of Social Science

Social Science Luncheon Seminar: "Power and influence in economics"
Kaushik Basu, Delhi School of Economics; Visiting Member, School of Social Science, IAS

November 15

School of Natural Sciences

Theoretical Physics Seminars: "Critical phenomena in disordered degenerate semiconductors and the random dirac operator"
Guest Lecturer: Eduardo Fradkin, University of Illinois

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November 18

School of Mathematics

Dynamical Systems Seminar: "Generally convergent iterations for the roots of polynomials"

Guest Lecturer: Michael Shub, Queens College, City University of New York

Marston Morse Memorial Lecture: "Symplectic geometry and the calculus of variations"

Guest Lecturer: Alan Weinstein, University of California, Berkeley

School of Social Science

Inequality Seminar: "Dostoevsky and the problem of inequality"

Joseph Frank, Princeton University; Director's Visitor, IAS

November 19

Concert

The Ridge String Quartet

School of Mathematics

D-Modules and Representations of Reductive Groups: "Review of 'classical' classification of irreducible Harish-Chandra modules" (continued)

Dragan Milićić, University of Utah; Visiting Member, School of Mathematics, IAS

Diophantine Approximation: "A new bound for the number of solutions of Thue equations"

Wolfgang M. Schmidt, University of Colorado; Visiting Member, School of Mathematics, IAS

Special Lecture: "Poisson geometry of the principal series, and non-linearizable structures"

Guest Lecturer: Alan Weinstein, University of California, Berkeley

November 20

School of Natural Sciences

Informal Discussion Group on Superstrings: "BRS quantization of strings"

Guest Lecturer: Emil Martinec, Princeton University

November 21

School of Mathematics

Special Lecture: "Introduction to simple strings for non-physicists" (continued)

Guest Lecturer: Edward Witten, Princeton University

Topology Seminar: "Stable homotopy types of stunted real projective spaces"

Guest Lecturer: Donald Davis, Lehigh University

Transcendental and Analytic Number Theory: "A proof of algebraic independence"

Michel Waldschmidt, Institut Henri Poincaré; Visiting Member, School of Mathematics, IAS

School of Social Science	Social Science Luncheon Seminar: "Culture and political crisis: 'Watergate' and Durkheimian sociology" Jeffrey C. Alexander, University of California, Los Angeles; Visiting Member, School of Social Science, IAS
November 22	
School of Natural Sciences	Theoretical Physics Seminar: "What's new in perturbative QCD?" John Collins, Illinois Institute of Technology; Visiting Member, School of Natural Sciences, IAS
November 25	
School of Mathematics	Dynamical Systems Seminar: "Information theory approach to spatio-temporal chaos" Robert Shaw, Visiting Member, School of Natural Sciences, IAS
School of Natural Sciences	Monday Lunchtime Seminar: "Effective actions for chiral fermions" Guest Lecturer: Stephen Della-Pietra, Harvard University
November 26	
School of Mathematics	D-Modules and Representations of Reductive Groups: "Cohomology of standard Harish-Chandra sheaves and Zuckerman modules" Dragan Milićić, University of Utah; Visiting Member, School of Mathematics, IAS
	Diophantine Approximation: "The number of solutions of the Thue-Mahler equation" Enrico Bombieri, Professor, School of Mathematics, IAS
School of Natural Sciences	Astrophysics Panel Discussion: "Reports on work in progress" Bohdan Paczynski, Princeton University; Visitor, School of Natural Sciences, IAS; and Guest Participant: Ed Jenkins, Princeton University
School of Social Science	Gender Seminar: "The problem of subjectivity" and "Psychoanalysis and feminism I: object-relation theory"
December 2	
School of Mathematics	Dynamical Systems Seminar: "Twist maps" Guest Lecturer: John N. Mather, Princeton University
School of Social Science	Inequality Seminar: "Anarchy, state, and utopia" Robert Amdur, Columbia University; Visiting Member, School of Social Science, IAS
December 3	
School of Mathematics	D-Modules and Representations of Reductive Groups: "Standard Harish-Chandra sheaves and Langlands classification" Dragan Milićić, University of Utah; Visiting Member, School of Mathematics, IAS and

School of Natural Sciences	"Zuckerman functors in D-module language" Joseph N. Bernstein, Harvard University; Visiting Member, School of Mathematics, IAS
	Diophantine Approximation: "On sieving limits and comparison of sieving methods" Atle Selberg, Professor, School of Mathematics, IAS
	Hermann Weyl Lectures: "Free boundary problems, a survey" Guest Lecturer: Luis A. Caffarelli, University of Chicago
School of Natural Sciences	Astrophysics Panel Discussion: "Reports on work in progress" Thomas Chester, California Institute of Technology; Visitor, School of Natural Sciences, IAS;
	Jeremy Goodman, Visiting Member, School of Natural Sciences, IAS;
	George Lake, Bell Laboratories; Visitor, School of Natural Sciences, IAS
December 4 School of Natural Sciences	Informal Seminar on Superstrings: "Covariant quantization of the superstring" Guest Lecturer: Emil Martinec, Princeton University
December 5 School of Historical Studies	Art History Colloquia: "Just a page of writing: notes on an eleventh-century picture cycle" Karl-August Wirth, University of Munich and University of Augsburg; Visiting Member, School of Historical Studies, IAS
School of Mathematics	Topology Seminar: "Structure of manifolds of non-positive curvature" Guest Lecturer: H. Werner Ballmann, University of Maryland
	Transcendental and Analytic Number Theory: "A zeros estimate for exponential polynomials" Robert Tubbs, University of Texas, Austin; Visiting Member, School of Mathematics, IAS
	Hermann Weyl Lectures: "Free boundary problems, a survey" (continued) Guest speaker: Luis A. Caffarelli, University of Chicago
School of Social Science	Social Science Luncheon Seminar: "Is gender a useful category of historical analysis?" Joan Scott, Professor, School of Social Science, IAS
	Gender Seminar: "Psychoanalysis and feminism II: Lacanian theory"
December 7-8 Conference	Society of Biblical Literature Convener: Donald F. McCabe, Princeton Epigraphical Project

December 9

School of Mathematics

Special Lecture: "Partial compactifications"
Guest Lecturer: E. Looijenga, Nijmegen, The Netherlands and
University of North Carolina, Chapel Hill

School of Natural Sciences

Monday Lunchtime Seminar: "Covariant action for an SU(2)
spinning string"
Guest Lecturer: M. Bernici, State University of New York at
Stony Brook

December 10

School of Mathematics

D-Modules and Representations of Reductive Groups:
"Zuckerman functors in D-module language" (continued)
Joseph N. Bernstein, Harvard University; Visiting Member,
School of Mathematics, IAS

Analytic Number Theory: "On sieving limits and comparison of
sieving methods" (continued)
Atle Selberg, Professor, School of Mathematics, IAS

Hermann Weyl Lectures: "Free boundary problems, a survey"
(continued)
Guest Lecturer: Luis A. Caffarelli, University of Chicago

School of Natural Sciences

Astrophysics Panel Discussion: "Reports on work in progress"
Guest Participants: Bruce Draine, Princeton University; Jerry
Ostriker, Princeton University; Adrian Russell, University of
Cambridge; Tony Stark, Bell Laboratories; Jens Villumsen,
California Institute of Technology

December 12

School of Mathematics

Topology Seminar: "Introduction to Hodge-De Rham theory"
Richard M. Hain, State University of New York, Buffalo; Visiting
Member, School of Mathematics, IAS

Transcendental and Analytic Number Theory: "Zeros estimates"
Patrice Philippon, Harvard University; Visiting Member, School
of Mathematics, IAS

Hermann Weyl Lectures: "Free boundary problems, a survey"
(continued)
Guest Lecturer: Luis A. Caffarelli, University of Chicago

School of Social Science

Social Science Luncheon Seminar: "Marxism and individualism"
Andrew Levine, University of Wisconsin, Madison; Visiting
Member, School of Social Science, IAS

December 13

School of Natural Sciences

Theoretical Physics Seminar: "Strange matter in the universe"
Guest Lecturer: Edward Farhi, Massachusetts Institute of
Technology

December 16

School of Mathematics

Special Lecture: "Report on the work of M. Saito"
Pierre Deligne, Professor, School of Mathematics, IAS

Members' Seminar: "Classifying spaces for Lie groups"
Eric M. Friedlander, Northwestern University; Visiting Member,
School of Mathematics, IAS

December 17

Concert

School of Mathematics

Ophra Yerushalmi, Pianist

D-Modules and Representations of Reductive Groups: "Proof of
the Kazhdan-Lusztig conjecture in non-integral case"
Joseph N. Bernstein, Harvard University; Visiting Member,
School of Mathematics, IAS

Analytic Number Theory: "Modular forms and the Chebotarev
density theorem"

V. Kumar Murty, Concordia University; Visiting Member, School
of Mathematics, IAS

School of Natural Sciences

Astrophysics Panel Discussion: "Reports on work in progress"
Stefano Casertano, Visiting Member, School of Natural Sciences,
IAS;

Bohdan Paczynski, Princeton University; Visitor, School of
Natural Sciences, IAS;

Paul Weissman, California Institute of Technology; Visitor,
School of Natural Sciences, IAS;

Guest Participants: Jim Gunn, Princeton University; Ed Jenkins,
Princeton University

December 18

School of Natural Sciences

Informal Seminar on Superstrings: "Superconformal ghost, I"
Guest Lecturer: Emil Martinec, Princeton University

Lecture: "Halley's Comet is coming soon!"

Paul Weissman, California Institute of Technology; Visitor,
School of Natural Sciences, IAS

December 19

School of Mathematics

Transcendental and Analytic Number Theory: "Some
diophantine inequalities related to the Nullstellensatz"

W. Dale Brownawell, Pennsylvania State University; Visiting
Member, School of Mathematics, IAS

January 7

School of Natural Sciences

Astrophysics Panel Discussion: "Reports on work in progress"
Piet Hut, Professor, School of Natural Sciences, IAS;

Jeremy Goodman, California Institute of Technology; Visiting
Member, School of Natural Sciences, IAS;

Guest Participant: Ed Groth, Princeton University

<i>January 9</i>	
School of Historical Studies	Art History Colloquia: "The idea of Pittsburgh" Franklin K. Toker, University of Pittsburgh; Visiting Member, School of Historical Studies, IAS
School of Social Science	Social Science Luncheon Seminar: "Why should we care about 'group' inequality?" Glenn C. Loury, Harvard University; Visiting Member, School of Social Science, IAS
<i>January 10</i>	
School of Historical Studies	Lecture: "On numismatic evidence" Guest Lecturer: Leo Mildenberg, Bank Leu AG, Zürich
<i>January 13</i>	
School of Social Science	Inequality Seminar: "Social background, life planning, and life career: participation in the labor force and the latest social position attained" Heiner Meulemann, University of Cologne; Visiting Member, School of Social Science, IAS
<i>January 14</i>	
School of Mathematics	Number Theory: "A problem about integers in base 4" Guest Lecturer: Alfred J. Van Der Poorten, Macquarie University
School of Natural Sciences	Astrophysics Panel Discussion: "Reports on work in progress" Moti Milgrom, Weizmann Institute; Visitor, School of Natural Sciences, IAS; Guest Participants: Roman Juszkiewicz, Copernicus Astronomical Center, Warsaw, Poland; Jim Peebles, Princeton University; Martin Schwarzschild, Princeton University
School of Social Science	Economics Seminar: "Transaction costs, institutions, and economic theory" Eric Jones, La Trobe University; Visiting Member, School of Social Science, IAS
<i>January 15</i>	
School of Natural Sciences	Informal Seminar on Superstrings: "Superconformal ghost, II" Guest Lecturer: Emil Martinec, Princeton University
<i>January 16</i>	
School of Mathematics	Transcendental and Number Theory: "A new approach to Baker's theorem on linear forms in logarithms, I" Gisbert Wüstholz, Max-Planck-Institut; Visiting Member, School of Mathematics, IAS
School of Social Science	Social Science Luncheon Seminar: "History and ethnography: desire, disguise, and dissimulation in early modern France" Sarah Hanley, University of Iowa; Visiting Member, School of Historical Studies, IAS

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January 17

School of Natural Sciences

Astronomy Seminar: "Active galactic nuclei and gamma-ray bursts—a unified picture"

Guest Lecturer: Andrzej A. Zdziarski, Center for Astrophysics, Harvard University

January 21

School of Mathematics

Number Theory: "Concerning exponential polynomials and recurrence sequences"

Guest Lecturer: Alfred J. Van Der Poorten, Macquarie University

Hermann Weyl Lectures: "Unitary representations of semisimple groups"

Guest Lecturer: David A. Vogan, Jr., Massachusetts Institute of Technology

School of Natural Sciences

Astrophysics Panel Discussion: "Reports on work in progress"

Guest Participants: Bruce Draine, Princeton University; Alex V. Filippenko, University of California at Berkeley; J. P. Ostriker, Princeton University

School of Social Science

Gender Seminar: "Is gender a useful category of historical analysis?"

Joan Scott, Professor, School of Social Science, IAS

January 23

School of Mathematics

Topology Seminar: "On duality groups"

Jean-Claude Hausmann, Université de Genève; Visiting Member, School of Mathematics, IAS

Transcendental and Number Theory: "A new approach to Baker's theorem on linear forms in logarithms, II"

Gisbert Wüstholz, Max-Planck-Institut; Visiting Member, School of Mathematics, IAS

Hermann Weyl Lectures: "Unitary representations of semisimple groups" (continued)

Guest Lecturer: David A. Vogan, Jr., Massachusetts Institute of Technology

School of Social Science

Social Science Luncheon Seminar: "Feminism and participatory democracy: some reflections on sexual difference and citizenship"

Guest Lecturer: Carole Pateman, Princeton University

January 27

School of Mathematics

Dynamical Systems Seminar: "Are computer pictures real? Pseudo-orbit shadowing in the family of tent maps"

Ethan Coven, Wesleyan University; Visiting Member, School of Mathematics, IAS

Special Lecture: "Fourier transform on 1-motives"

Gérard Laumon, Université de Paris—Sud; Visitor, School of Mathematics, IAS

School of Natural Sciences

Theoretical Physics Seminar: "One loop effective Lagrangians and compactified superstrings"
 Guest Lecturer: John Breit, University of Pennsylvania

School of Social Science

Inequality Seminar: "The emotive and cognitive view of justice"
 Ekkehart Schlicht, University of Mannheim; Visiting Member, School of Social Science, IAS

January 28

School of Mathematics

Number Theory: "The large sieve with multiplicative coefficients"
 Adolf Hildebrand, University of Pennsylvania; Visiting Member, School of Mathematics, IAS

Hermann Weyl Lectures: "Unitary representations of semisimple groups" (continued)
 Guest Lecturer: David A. Vogan, Jr., Massachusetts Institute of Technology

School of Natural Sciences

Astrophysics Panel Discussion: "Reports on work in progress"
 Guest Participants: Richard Gott, Princeton University; Julia Hester, Massachusetts Institute of Technology; Steve McMillan, Northwestern University

School of Social Science

Economics Seminar: "The economics of justice"
 Kaushik Basu, Delhi School of Economics; Visiting Member, School of Social Science, IAS

January 30

School of Mathematics

Transcendental and Number Theory: "Linear relations on group varieties, I"
 David Masser, University of Michigan; Visiting Member, School of Mathematics, IAS

Hermann Weyl Lectures: "Unitary representation of semisimple groups" (continued)
 Guest Lecturer: David A. Vogan, Jr., Massachusetts Institute of Technology

School of Social Science

Social Science Luncheon Seminar: "Interaction of 'economic' and 'social' influences"
 Ekkehard Schlicht, University of Mannheim; Visiting Member, School of Social Science, IAS

January 31-February 2

Conference

Democracy in Israel
 Convener: Ilai Alon, Visiting Professor, Department of Near Eastern Studies, Princeton University

February 3

School of Mathematics

Dynamical Systems Seminar: "Geometry of the Mandelbrot set"
 John W. Milnor, Professor, School of Mathematics, IAS

School of Natural Sciences

Monday Lunchtime Seminar: "Supersymmetry anomalies"
Hai-cang Ren, Columbia University; Visiting Member, School of Natural Sciences, IAS

February 4

School of Mathematics

Number Theory: "Fourier coefficients of modular forms of half-integral weight"
Henryk Iwaniec, Polish Academy of Sciences; Visiting Member, School of Mathematics, IAS

School of Natural Sciences

Astrophysics Panel Discussion: "Reports on work in progress"
Jeremy Goodman, California Institute of Technology; Visiting Member, School of Natural Sciences, IAS;
Guest Participants: Gerald Cecil, University of Hawaii; Arthur Champagne, Princeton University; Russell Kulsrud, Princeton Plasma Physics Laboratory; Phil Solomon, State University of New York at Stony Brook

February 6

School of Historical Studies

Art History Colloquia: "Roma à Paris: Les tableaux du Maréchal de Crequy (1638)"
Jean-Claude Boyer, Centre National de la Recherche Scientifique; Visiting Member, School of Historical Studies, IAS

School of Mathematics

Topology Seminar: "Projective Stiefel manifolds"
Guest Lecturer: Enrique Antoniano, Centro de Investigacion y de Estudios Avanzados del I.P.N., Mexico

Transcendental and Number Theory: "Linear relations on group varieties, II"
David Masser, University of Michigan; Visiting Member, School of Mathematics, IAS

School of Social Science

Social Science Luncheon Seminar: "The radical right in postwar Italy"
Franco Ferraresi, University of Turin; Visiting Member, School of Social Science, IAS

February 7

School of Natural Sciences

Theoretical Physics Seminar: "Multi-loop amplitudes in the Bosonic string"
Guest Lecturer: Eric D'Hoker, Columbia University

Astronomy Seminar: "A slice of the universe"
Guest Lecturer: Valerie de Lapparent, Center for Astrophysics, Harvard University

School of Social Science

Gender Seminar: "Feminist theory and gendered time"
Carmen Sirianni, Northeastern University; Visiting Member, School of Social Science, IAS

February 10

School of Mathematics

Dynamical Systems Seminar: "Laminations and quadratic maps"
Guest Lecturer: William Thurston, Princeton University

Members' Seminar: "Multiplicities on real hypersurfaces and $\bar{\partial}$ "
 John P. D'Angelo, University of Illinois; Visiting Member, School of Mathematics, IAS

School of Social Science

Inequality Seminar: "Taking equality very seriously: striving for equality as a source of further inequality"

István Rév, Karl Marx University of Economics, Budapest;
 Visiting Member, School of Social Science, IAS

February 11

School of Natural Sciences

Astrophysics Panel Discussion: "Reports on work in progress"

Piet Hut, Professor, School of Natural Sciences, IAS;

Guest Participants: Todd Lauer, Princeton University; Ed Turner, Princeton University; Jacqueline van Gorkom, National Radio and Astronomy Observatory, Princeton

School of Social Science

Economics Seminar: "The problem with neoclassical institutional economics: a critique with special reference to the North/Thomas model of pre-1500 Europe"

Ekkehart Schlicht, University of Mannheim; Visiting Member, School of Social Science, IAS

February 12

School of Natural Sciences

Special Physics Seminar: "Strings and supermoduli"

Guest Lecturer: Philip Nelson, Harvard University

February 13

School of Mathematics

Topology Seminar: "Characteristic classes, singular embeddings, and intersection homology"

Guest Lecturer: Julius Shaneson, Rutgers University

Transcendental and Number Theory: "Sums of S-units"

David Masser, University of Michigan; Visiting Member, School of Mathematics, IAS

School of Social Science

Social Science Luncheon Seminar: "Education and value change: 'achievement' in Germany between the fifties and eighties as an example"

Heiner Meulemann, University of Cologne; Visiting Member, School of Social Science, IAS

February 14

School of Natural Sciences

Theoretical Physics Seminar: "Ashkin-Teller and Gross-Neveu models: new relations and results, II"

Guest Lecturer: Ramamurti Shankar, Yale University

February 17

School of Natural Sciences

Monday Lunchtime Seminar: "Instantons and the super Yang-Mills beta function"

Timothy Morris, University of Southampton; Visiting Member, School of Natural Sciences, IAS

February 18

School of Social Science

Gender Seminar: "Greek and Roman gynecology"
Ann Ellis Hanson, Fordham University; Visiting Member, School of Historical Studies, IAS

February 20

School of Mathematics

Topology Seminar: "K-theory and cyclic homology"
Charles A. Weibel, Rutgers University; Visiting Member, School of Mathematics, IAS

School of Social Science

Social Science Luncheon Seminar: "Have Americans become more selfish?"

Christopher Jencks, Northwestern University; Visiting Member, School of Social Science, IAS

February 21

School of Natural Sciences

Theoretical Physics Seminar: "String generated gravity theories"
Guest Lecturer: Stanley Deser, Brandeis University

February 24

School of Mathematics

Members' Seminar: "Cohomology of discrete groups and Langlands functoriality"

Guest Lecturer: Jean-Pierre Labesse, Université de Dijon

February 25

School of Mathematics

D-Modules and Representations of Reductive Groups: "Fourier transform of D-modules, I"

Bernard Malgrange, Institut Fourier; Visiting Member, School of Mathematics, IAS

Number Theory: "Integral points on elliptic curves"

Guest Lecturer: J. Silverman, Massachusetts Institute of Technology

School of Natural Sciences

Astrophysics Panel Discussion: "Reports on work in progress"
Donald Schneider, California Institute of Technology; Visiting Member, School of Natural Sciences, IAS;

Guest Participants: Stephen Lubow, Space Telescope Institute, The Johns Hopkins University; Jim Peebles, Princeton University

February 26

School of Historical Studies

Lecture: "The royal silver treasure of Rogozen, Bulgaria"

Georgi Mihailov, University of Sophia; Visiting Member, School of Historical Studies, IAS

February 27

School of Mathematics

Topology Seminar: "Geometric basis, topological equivalence and a theorem of Le-Ramanujam"

Guest Lecturer: Susan Szczepanski, Lehigh University

Transcendental and Number Theory: "Algebraic groups and geometry of numbers"

Gisbert Wüstholz, Max-Planck-Institut; Visiting Member, School of Mathematics, IAS

School of Social Science	Social Science Luncheon Seminar: "The advantages of being atomized" István Rév, Karl Marx University of Economics, Budapest; Visiting Member, School of Social Science, IAS
<i>March 3</i>	
School of Mathematics	Members' Seminar: "Generalized Dirichlet series and b-functions" Benjamin L. Lichtin, University of Rochester; Visiting Member, School of Mathematics, IAS
School of Natural Sciences	Monday Lunchtime Seminar: "The world-sheet supergravity of the heterotic string" Guest Lecturer: Mark Evans, Rockefeller University
<i>March 4</i>	
School of Mathematics	D-Modules and Representations of Reductive Groups: "Fourier transform of D-modules, II" Bernard Malgrange, Institut Fourier; Visiting Member, School of Mathematics, IAS
	Number Theory: "The 'exterior square' automorphic L-functions on $GL(4)$ " Daniel Bump, University of Texas, Austin; Visiting Member, School of Mathematics, IAS
School of Social Science	Gender Seminar: "Feminist theory and gendered time" Carmen Sirianni, Northeastern University; Visiting Member, School of Social Science, IAS
<i>March 5</i>	
School of Natural Sciences	Special Physics Seminar: "Cosmic strings and the formation of galaxies" Guest Lecturer: Robert Brandenberger, Department of Applied Mathematics and Theoretical Physics, Harvard University
<i>March 6</i>	
School of Historical Studies	Art History Colloquia: "Art in the service of an oppressed nation: Romantic painting in Poland" Jan Ostrowski, Jagiellonian University; Visiting Member, School of Historical Studies, IAS
School of Mathematics	Topology Seminar: "Smith theory revisited" Guest Lecturer: Clarence Wilkerson, Wayne State University
	Transcendental Number Theory: "On Baker's theorem on linear forms in logarithms" Gisbert Wüstholz, Max-Planck-Institut; Visiting Member, School of Mathematics, IAS
	Topology Seminar: "On the diffeomorphism type of certain elliptic surfaces" Guest Lecturer: John Morgan, Columbia University

School of Natural Sciences

Special Physics Seminar: "Partially broken global supersymmetry and the superstring"
Guest Lecturer: Joe Polchinski, University of Texas

School of Social Science

Social Science Luncheon Seminar: "Individualism without community? The political theory of Frederick Hayek"
Elisabetta Galeotti, University of Messina; Visitor, School of Social Science, IAS

March 7

School of Natural Sciences

Theoretical Physics Seminar: "Quantization of topologically massive chromodynamics"
Guest Lecturer: Robert Pisarski, Fermi National Accelerator Laboratory

March 10

School of Mathematics

Dynamical Systems Seminar: "Multiple bifurcations"
Guest Speaker: John Guckenheimer, Cornell University

March 11

School of Mathematics

D-Modules and Representations of Reductive Groups: "Global relations between the exponents of a differential operator"
Daniel Bertrand, Université de Paris VI; Visitor, School of Mathematics, IAS

Number Theory: "Counting solutions of binomial and trinomial Thue equations and inequalities"
Guest Lecturer: Julia Mueller, Fordham University; Visitor, School of Mathematics, IAS

School of Natural Sciences

Astrophysics Panel Discussion: "Reports on work in progress"
Piet Hut, Professor, School of Natural Sciences, IAS;
Guest Participants: Peter Meszaros, Pennsylvania State University; Peter Teubner, Kepteyn Astronomical Institute; Ed Turner, Princeton University; Jacqueline van Gorkom, National Radio and Astronomy Observatory, Princeton

March 13

School of Mathematics

Transcendental Number Theory: "On the Siegel-Mahler-Lang Theorem"
Daniel Bertrand, Université de Paris VI; Visitor, School of Mathematics, IAS

School of Social Science

Social Science Luncheon Seminar: "Some comments about the concept of public opinion"
Bernard Manin, Centre National de la Recherche Scientifique; Visiting Member, School of Social Science, IAS

March 14

School of Natural Sciences

Theoretical Physics Seminar: "Wave equations: a global, uniform semiclassical approximation"
Guest Lecturer: John R. Klauder, Bell Laboratories

March 17

School of Historical Studies

Lecture: "The Nabataeans: A new survey"

Guest Lecturer: Karl Schmitt-Korte, German-Jordanian Society

School of Mathematics

D-Modules and Representations of Reductive Groups:

"Estimates of exponents for hypersurface singularities"

Benjamin L. Lichtin, University of Rochester; Visiting Member, School of Mathematics, IAS

School of Natural Sciences

Monday Lunchtime Seminar: "CP-violation effects in hadronic decays of $B^0-\bar{B}^0$ system within the framework of Kobayashi-Maskawa model"

Dong sheng Du, Academia Sinica; Visiting Member, School of Natural Sciences, IAS

March 18

School of Mathematics

D-Modules and Representations of Reductive Groups: "Fourier transform of D-modules, III"

Bernard Malgrange, Institut Fourier; Visiting Member, School of Mathematics, IAS

Number Theory: "Thue equations with few coefficients"

Wolfgang M. Schmidt, University of Colorado; Visiting Member, School of Mathematics, IAS

School of Natural Sciences

Astrophysics Panel Discussion: "Reports on work in progress"

Guest Participants: Edward Loh, Princeton University; Ed Turner, Princeton University; John Weissheit, Princeton Plasma Physics Laboratory

School of Social Science

Gender Seminar: "Feminists and the issue of pornography"

Jane Mansbridge, Northwestern University; Visiting Member, School of Social Science, IAS

March 19

School of Mathematics

Transcendental Number Theory: "Effective approximations to cubic irrationals"

Guest Lecturer: Alan Baker, University of Cambridge

March 20

School of Mathematics

Topology Seminar: "Stable splittings of mapping spaces"

Guest Lecturer: Carl-Friedrich Bödigheimer, University of Kentucky

School of Social Science

Social Science Luncheon Seminar: "Religious ideas and the rise of romantic love in eighteenth-century America"

Ruth Bloch, University of California at Los Angeles; Visitor, School of Social Science, IAS

March 21

School of Natural Sciences

Theoretical Physics Seminar: "Nonlinear σ -models as s-matrix generators of strings"

Antal Jevicki, Brown University; Visiting Member, School of Natural Sciences, IAS

March 24

School of Mathematics

D-Modules and Representations of Reductive Groups:
"Examples of characteristic varieties"

Zoghman Mebkhout, Université Paris VIII; Visiting Member,
School of Mathematics, IAS

School of Natural Sciences

Theoretical Physics Luncheon Seminar: "Theta function and
superstring amplitudes"

Guest Lecturer: Gregory Moore, Harvard University

March 25

Concert

Music by Three

School of Mathematics

D-Modules and Representations of Reductive Groups: "Fourier
transform of D-modules, IV"

Bernard Malgrange, Institut Fourier; Visiting Member, School of
Mathematics, IAS

Transcendental Number Theory: "A p-adic transcendence
measure for Weierstrass p-functions"

Guest Lecturer: Jim Fennell, Pennsylvania State University

March 27

School of Mathematics

Topology Seminar: "Reductive group actions on affine varieties"

Guest Lecturer: Edward Petrie, Rutgers University

Transcendental Number Theory: "G-functions: p-adic analysis
and transcendence"

Guest Lecturer: Yves André, Institut Henri Poincaré
and

"Effective approximations to cubic irrationals" (continued)

Guest Lecturer: Alan Baker, University of Cambridge

School of Social Science

Social Science Luncheon Seminar: "Economic growth in the
premodern world"

Eric Jones, La Trobe University; Visiting Member, School of
Social Science, IAS

March 31

School of Mathematics

Members' Seminar: "Twisted difference operators and perturbed
Chebyshev polynomials"

Attila Máté, Brooklyn College of The City University of New
York; Visiting Member, School of Mathematics, IAS

April 1

School of Mathematics

D-Modules and Representations of Reductive Groups:
"Degeneration of the Hodge to De Rham spectral sequence

(following L. Illusie)"

Pierre Deligne, Professor, School of Mathematics, IAS

School of Natural Sciences

Astrophysics Panel Discussion: "Reports on work in progress"

Guest Participants: Bruce Draine, Princeton University; Franz
Kahn, University of Manchester; Robert Wilson, Bell
Laboratories; Farhad Yusef-Zadeh, Columbia University

School of Social Science

Gender Seminar: "Anthropology: readings on gender"
 Joan Vincent, Barnard College; Visiting Member, School of Social
 Science, IAS

April 3

School of Mathematics

Topology Seminar: "On the diffeomorphism type of certain
 elliptic surfaces"
 Guest Lecturer: John Morgan, Columbia University

Diophantine Approximation: "Report on the Oberwolfach
 meeting"

W. Dale Brownawell, Pennsylvania State University; Visiting
 Member, School of Mathematics, IAS

School of Historical Studies

Art History Colloquia: "Who was Arvianotorfe? A Panofsky
 problem revised"
 Dieter Wuttke, Universität Bamberg; Visiting Member, School of
 Historical Studies, IAS

School of Social Science

Social Science Luncheon Seminar: "Worker participation in the
 late twentieth century: some critical issues"
 Carmen Sirianni, Northeastern University; Visiting Member,
 School of Social Science, IAS

April 4

School of Natural Sciences

Theoretical Physics Seminar: "Fourier acceleration: lattice QCD,
 fractals, and beyond"
 Guest Lecturer: Ghassan Batrouni, Cornell University

April 7

School of Mathematics

Dynamical Systems Seminar: "Feigenbaum's quantitative
 discovery for one-dimensional dynamical systems"
 Guest Lecturer: Dennis Sullivan, City University of New York

April 8

School of Mathematics

Diophantine Approximation: "Effective types of irrationality for
 roots of a class of trinomial equations"
 Enrico Bombieri, Professor, School of Mathematics, IAS

School of Natural Sciences

Astrophysics Panel Discussion: "Reports on work in progress"
 James Binney, University of Oxford; Visiting Member, School of
 Natural Sciences, IAS;
 Fang Li-Zhi, University of Science and Technology of China;
 Visitor, School of Natural Sciences, IAS;
 Guest Participants: C. Alcock, Massachusetts Institute of
 Technology; J. Ostriker, Princeton University

April 10

School of Natural Sciences

Theoretical Physics Seminar: "Fisher scaling in pure lattice gauge
 theories"
 Guest Lecturer: Bern Berg, Florida State University

92 Record of Events

School of Social Science

April 11

School of Natural Sciences

April 14

School of Historical Studies

School of Natural Sciences

April 15

School of Natural Sciences

School of Social Science

April 16

School of Natural Sciences

April 17

School of Social Science

April 18

School of Natural Sciences

April 21

School of Natural Sciences

Social Science Luncheon Seminar: "Invisible women: prophets and witches in seventeenth-century England"
Phyllis Mack, Rutgers University; School of Historical Studies, IAS

Theoretical Physics Seminar: "Dilaton tadpoles, string condensates, scale invariance, and the cosmological constant"
Guest Lecturer: Leonard Susskind, Stanford University

Lecture: "Power and fiscal accountability: a crisis of fidelity in the twelfth century"
Guest Lecturer: Thomas N. Bisson, University of California at Berkeley

Monday Lunchtime Seminar: "Normalization of hard QCD cross-sections"

George Sterman, State University of New York at Stony Brook; Visiting Member, School of Natural Sciences, IAS

Astrophysics Panel Discussion: "Reports on work in progress"
Donald Schneider, California Institute of Technology; Visiting Member, School of Natural Sciences, IAS;

Guest Participants: Leo Blitz, University of Maryland; Rich Gott, Princeton University; Jim Gunn, Princeton University; Ed Jenkins, Princeton University

Gender Seminar: "A critique of recent efforts to improve the marriage of Marxism and feminism"

Guest Lecturer: Midge Quant, Princeton, New Jersey

Theoretical Physics Seminar: "Spectrum calculations in lattice gauge—Higgs systems"

Junko Shigemitsu, Ohio State University; Visitor, School of Natural Sciences, IAS

Social Science Luncheon Seminar: "Risk perception"

Guest Lecturer: Mary Douglas, Rutgers University

Theoretical Physics Seminar: "Curvature induced asymptotic freedom"

Guest Lecturer: Leonard Parker, University of Wisconsin, Milwaukee

Monday Lunchtime Seminar: "Instantons and the super Yang-Mills beta function"

Timothy Morris, University of Southampton; Visiting Member, School of Natural Sciences, IAS

April 22

School of Natural Sciences

Astrophysics Panel Discussion: "Reports on work in progress"
 Bohdan Paczynski, Princeton University; Visitor, School of
 Natural Sciences, IAS;
 Guest Participant: Margaret Geller, Center for Astrophysics,
 Harvard University

April 29

School of Natural Sciences

Astrophysics Panel Discussion: "Reports on work in progress"
 Bohdan Paczynski, Princeton University; Visitor, School of
 Natural Sciences, IAS;
 Tsvi Piran, Visiting Member, School of Natural Sciences, IAS;
 Guest Participants: Richard Gott, Princeton University;
 Alexander Wolszczan, Arecibo Observatory

School of Social Science

Gender Seminar: "Sexual contract and marriage contract"
 Guest Lecturer: Carole Pateman, Princeton University

May 1

School of Social Science

Social Science Luncheon Seminar: "Free speech and its limits"
 Robert Amdur, Columbia University; Visiting Member, School of
 Social Science, IAS

May 2

School of Natural Sciences

Theoretical Physics Seminar: "Cosmic strings on orbifolds"
 Jonathon Bagger, Dartmouth College; Visiting Member, School
 of Natural Sciences, IAS

May 5

School of Natural Sciences

Monday Lunchtime Seminars: "Quaternionic quantum field
 theory: mathematical formalism"
 Stephen L. Adler, Professor, School of Natural Sciences, IAS

May 7

School of Natural Sciences

Theoretical Physics Seminar: "Gauge excitations in string
 theories"
 Guest Lecturer: Rafael Nepomechie, University of Washington

School of Social Science

Social Science Luncheon Seminar: "Human nature in
 architectural theory: the example of Louis Kahn"
 Robert Gutman, Rutgers University and Princeton University;
 Visitor, School of Historical Studies, IAS

May 12

School of Natural Sciences

Monday Lunchtime Seminar: "Quaternionic field theory and CP
 violations in K decays"
 Stephen L. Adler, Professor, School of Natural Sciences, IAS

May 13

School of Natural Sciences

Astrophysics Panel Discussion: "Reports on work in progress"
 Guest Participants: Walter Lewin, Massachusetts Institute of
 Technology; Jerry Ostriker, Princeton University; David
 Spergel, Center for Astrophysics, Harvard University; Mario
 Vietri, Osservatorio Astrofisico Acetri

94 Record of Events

May 15-16

Meeting

Association of Members of the Institute for Advanced Study

May 16

School of Natural Sciences

Theoretical Physics Seminar: "Conformal field theory on a Riemann surface"

Guest Lecturer: Emil Martinec, Princeton University

School of Social Science

Conference: "Women's history seminar"

Joan Scott, Professor, School of Social Science, IAS

May 19

School of Natural Sciences

Monday Lunchtime Seminar: "Non-perturbative effects on the string world sheet"

Michael Dine, Visiting Member, School of Natural Sciences, IAS

May 20

School of Natural Sciences

Astrophysics Panel Discussion: "Reports on work in progress"

Guest Participants: John Bally, Bell Laboratories; Riccardo Giovanelli, Arecibo Observatory; Jeff Kuhn, Princeton University; Ed Turner, Princeton University

May 28

School of Natural Sciences

Theoretical Physics Seminar: "The gluon is massive: results of a lattice Monte Carlo calculation"

Guest Lecturer: Jeffrey Mandula, Department of Energy

May 28-31

Symposium

International Astronomers Union: "Structure and dynamics of elliptical galaxies"

Conveners: Stefano Casertano and Tim de Zeeuw, Visiting Members, School of Natural Sciences, IAS

June 2-4

Workshop

Stellar Dynamics Workshop

Convener: Piet Hut, Professor, School of Natural Sciences, IAS

June 10

School of Natural Sciences

Astrophysics Panel Discussion: "Reports on work in progress"

Guest Participants: Sverre Aarseth, University of Cambridge;

Chris McKee, University of California at Berkeley; Steve McMillan, Northwestern University; Bob Schongmer, Rutgers University

June 11-13

Conference

Women in Twentieth Century American Politics

Conveners: Joan Scott, Professor, School of Social Science, IAS; and Louise Tilly, New School for Social Research

In addition, the following lectures at the Institute were arranged by the Princeton Society of the Archaeological Institute of America.

October 9	Lecture: "New light on the Maya" Guest Lecturer: Norman Hammond, Rutgers University
November 13	Lecture: "Bathing and baths in classical antiquity" Guest Lecturer: Fikret Yegul, University of California at Santa Barbara
December 11	Lecture: "Metalwork in ancient Chinese, with some Near Eastern comparisons" Guest Lecturer: Robert Bagley, Princeton University
February 12	Lecture: "The Princeton University excavations at Polis, Cyprus" Guest Lecturer: William A. P. Childs, Princeton University
March 12	Lecture: "Qasr Ibrim: a fortress on the Egyptian—Nubian frontier" Guest Lecturer: William Y. Adams, University of Kentucky
April 9	Lecture: "Athens in the time of Byron" Guest Lecturer: C.W.J. Eliot, Mount Allison University

Report of the Treasurer

Institute for Advanced Study
Louis Bamberger and Mrs. Felix Fuld Foundation

The market value of the Institute's endowment totaled \$165,242,290 on June 30, 1986.

During fiscal year 1986, total expenditures were \$12.0 million. After applying approximately \$2.6 million in operating fund gifts and grants against these expenditures, the Institute was required to provide in excess of \$9 million from endowment resources. This represents approximately 6.6% of the average market value of the endowment for the fiscal year ended June 30, 1986, as compared to 7.0% for fiscal year 1985.

The performance of the Institute's portfolio is measured annually by Hamilton, Johnston & Co., Inc. Over the ten-year period ending June 30, 1986, dividend and interest income

and net realized and unrealized gains combined for a total average annual compound rate of return on Institute investments of 17.9 percent. Over the past five years, the average annual compound rate of return was 17.8 percent. For fiscal 1986, the annual rate of return was 28.7 percent.

The financial statements of the Institute for Advanced Study are audited by Deloitte Haskins & Sells. The auditors' opinion letter and statements for the fiscal year ended June 30, 1986, follow this report.

Ralph E. Hansmann
Treasurer

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Accountants' Opinion

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Exhibit C—Statement of Changes in Financial Position for the Year Ended June 30, 1986

Summary of Significant Accounting Policies

Notes to Financial Statements

Deloitte Haskins + Sells

685 College Road East
Princeton Forrestal Center
Princeton, New Jersey 08540
(609) 520-2300
Cable DEHANDS

The Board of Trustees,
Institute for Advanced Study-
Louis Bamberger and
Mrs. Felix Fuld Foundation
Princeton, New Jersey

We have examined the financial statements of the Institute for Advanced Study-Louis Bamberger and Mrs. Felix Fuld Foundation as of June 30, 1986 and for the year then ended, listed in the foregoing table of contents. Our examination was made in accordance with generally accepted auditing standards and, accordingly, included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, such financial statements present fairly the financial position of the Institute at June 30, 1986 and the results of its operations and the changes in its financial position for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Deloitte Haskins + Sells

October 10, 1986

Institute for Advanced Study
Louis Bamberger and Mrs. Felix Fuld Foundation
 Balance Sheet—June 30, 1986
 (With Comparative Totals for 1985)

Exhibit A

ASSETS

Operating Funds:

	1986	1985
Cash	\$ 25,802	\$ 24,171
Temporary investments	855,120	456,117
Accounts and notes receivable	71,758	111,736
Government contracts receivable	183,943	388,883
Private gifts and grants receivable	40,879	36,625
Accrued income on investments	1,217,476	1,185,579
Deferred charges	156,129	126,955
Due from plant funds	293,241	
Total operating funds	\$ 2,551,107	\$ 2,623,307

Plant Funds:

Temporary investments	\$ 18,000	\$ 22,595
Debt service fund deposits	434,232	432,611
Accrued income on investments		14,202
Marketable securities, at cost approximating market (Note D)		272,123
Unamortized debt expense	77,679	80,786
Land, buildings and improvements, equipment and library books (including rare book collection) at cost, less accumulated depreciation of \$11,222,044 at June 30, 1986 (Notes C and D)	15,898,601	15,285,006
Total plant funds	\$ 16,428,512	\$ 16,107,323

Endowment and Similar Funds: (Note B)

Due from brokers, net	\$ 522,775	
Marketable securities, at cost (Note D)	136,537,598	\$123,405,014
Mortgages and notes receivable from faculty and staff	2,224,585	1,375,473
Total endowment and similar funds	\$139,284,958	\$124,780,487

LIABILITIES AND FUND BALANCES

Operating Funds:

Accounts payable, accrued expenses, etc.	\$ 548,724	\$ 312,622
Deferred restricted revenue (Note G)	603,567	540,627
Fund balance (Exhibit B)—unrestricted	1,398,816	1,770,058
Total operating funds	\$ 2,551,107	\$ 2,623,307

Plant Funds:

Interest payable (Note D)	\$ 314,233	\$ 317,611
Long-term debt (Note D)	8,616,544	8,762,766
Due to operating funds		293,241
Plant funds balance (Exhibit B)	7,497,735	6,733,705
Total plant funds	\$ 16,428,512	\$ 16,107,323

Endowment and Similar Funds:

Due to brokers, net		\$ 2,587,880
Fund balances (Exhibit B):		
Endowment funds	\$ 33,835,693	28,913,311
Quasi-endowment funds:		
Restricted	4,908,988	4,254,860
Unrestricted:		
Designated	6,839,419	5,755,389
Undesignated	93,700,858	83,269,047
Total endowment and similar funds	\$139,284,958	\$124,780,487

See notes to financial statements.

**Institute for Advanced Study
Louis Bamberger and Mrs. Felix Fuld Foundation**
Statement of Support and Revenue, Expenses, Capital Additions, and Changes in Fund Balances
for the Year Ended June 30, 1986 (With Comparative Totals for 1985)

Exhibit B

	Operating Funds Unrestricted	Operating Funds Restricted	Total	Plant Funds	Endowment and Similar Funds	Total 1986 All Funds	Total 1985 All Funds
Support and Revenue:							
Endowment income (net of management fees)	\$5,665,326	\$2,446,097	\$ 8,111,423			\$ 8,111,423	\$ 8,903,014
Private gifts and grants	9,257	2,022,381	2,031,638			2,031,638	1,558,810
Government contracts		576,067	576,067			576,067	632,892
Total support and revenue	5,674,583	5,044,545	10,719,128			10,719,128	11,094,716
Expenses:							
School of Mathematics	970,459	1,322,893	2,293,352	\$ 132,698		2,426,050	2,206,446
School of Natural Sciences	1,146,542	1,260,700	2,407,242	356,155		2,763,397	2,295,968
School of Historical Studies	1,655,086	322,848	1,977,934	224,557		2,202,491	2,140,114
School of Social Science		1,004,735	1,004,735	74,604		1,079,339	1,098,406
Libraries	928,546	154,339	1,082,855	79,284		1,162,169	988,909
Director's Special Purpose Fund	55,710	41,231	96,941	826		97,767	77,893
Administration and General	1,812,549	14,420	1,826,969	157,322		1,984,291	1,872,554
Auxiliary Activity — tenants' housing expenses net of \$93,848 of revenue in 1986		177,277	83,364	260,641	64,047	324,688	299,849
Total expenses	6,746,169		4,204,530	10,950,699	1,089,493	12,040,192	10,980,139
Excess (deficiency) of support and revenue over expenses before capital additions	(1,071,586)		840,015	(231,571)	(1,089,493)	(1,321,064)	114,577

Capital Additions:					
Gifts	739,910	\$ 305,009	1,044,919	681,384	
Realized net gains on investments	153,862	17,603,604	17,757,466	9,071,067	
Investment income	3,818		3,818	29,568	
Total capital additions	897,590	17,908,613	18,806,203	9,782,019	9,782,019
Excess (deficiency) of support and revenue over expenses after capital additions					
(\$1,071,586)	840,015	(231,571)	(191,903)	17,908,613	17,485,139
Fund Balances at Beginning of Year	1,770,058	-0-	1,770,058	6,733,705	122,192,607
Transfers:					
Proceeds from disposal of plant facilities	350,118	350,188	(350,118)		
Plant acquisitions and principal debt service payments	(1,306,051)	(1,306,051)	1,306,051	(1,656,277)	(1,656,277)
Quasi-endowment funds utilized	1,656,277				
Transfers to endowment and similar funds					
Fund Balances at End of Year	\$1,398,816	\$ -0-	\$ 1,398,816	\$7,497,735	\$139,284,958
	=====	=====	=====	=====	=====

See notes to financial statements.

**Institute for Advanced Study
Louis Bamberger and Mrs. Felix Fuld Foundation**

**Statement of Changes in Financial Position
for the Year Ended June 30, 1986 (With Comparative Totals for 1985)**

Exhibit C

	<i>Operating Funds</i>	<i>Plant Funds</i>	<i>Endowment & Similar Funds</i>	<i>TOTAL 1986 ALL FUNDS</i>	<i>TOTAL 1985 ALL FUNDS</i>
Resources Provided:					
Excess (deficiency) of support and revenue over expenses before capital additions	\$ (231,571)	\$ (1,089,493)		\$ (1,321,064)	\$ 114,577
Capital additions:					
Gifts	739,910		\$ 305,009	1,044,919	681,384
Realized net gains on investments	153,862	17,603,604	17,757,466	9,071,067	29,568
Investment income	3,818		3,818		
Excess (deficiency) of support and revenue over expenses after capital additions	(231,571)	(191,903)	17,908,613	17,485,139	9,896,596
Items not using (providing) resources:					
Provision for depreciation	1,089,493			1,089,493	944,652
Decrease in unamortized debt service expense	3,107			3,107	3,107
Loss (Gain) on disposition of investments— net	(153,862)	(17,603,604)	(17,757,466)	(9,011,279)	142,640,454
Proceeds from sale of investments	272,123	231,343,729	231,615,852	350,118	
Proceeds from disposal of plant facilities	350,118			533,905	15,663
Decrease in receivables	533,905			14,202	
Decrease in accrued income	14,202				
Decrease in deferred charges					
Increase in payables	236,102		236,102	16,753	
Increase in deferred restricted revenue	62,940		62,940	2,777,913	
Increase in deferred restricted revenue				66,667	
Total resources provided	601,376	1,383,278	231,648,738	233,633,392	147,350,526

Resources Used:				
Purchases of investments	227,721,821		227,721,821	145,823,308
Purchases of plant facilities and equipment	1,899,344	522,775	1,899,344	856,003
Increase in receivables	29,174	1,621	522,775	285,747
Increase in deferred charges			29,174	
Increase in debt service fund deposits			1,621	1,769
Increase in accrued income	31,897	296,619	31,897	48,121
Decrease in payables		146,222	2,884,499	64,554
Reduction of long-term debt			146,222	140,221
Total resources used	<u>61,071</u>	<u>2,343,806</u>	<u>230,832,476</u>	<u>233,237,353</u>
 Transfers:				
Proceeds from disposal of plant facilities	350,118	(350,118)		
Plant acquisitions and principal debt service payments	(1,306,051)	1,306,051	(1,306,051)	
Quasi-endowment funds utilized	1,656,277		(1,656,277)	
Transfers to endowment and similar funds	(840,015)		840,015	
Total transfers	<u>(139,671)</u>	<u>955,933</u>	<u>(816,262)</u>	
Increase (decrease) in cash and temporary investments	<u>\$ 400,634</u>	<u>\$ (4,595)</u>	<u>\$ - 0 -</u>	<u>\$ 396,039</u>

See notes to financial statements.

Notes to Financial Statements

June 30, 1986

A. Summary of Significant Accounting Policies

The Institute for Advanced Study, an independent, private institution devoted to the encouragement, support, and patronage of learning, was founded in 1930 as a community of scholars where intellectual inquiry could be carried out in the most favorable circumstances.

Focused on mathematics and classical studies at the outset, the Institute today consists of the School of Historical Studies, the School of Mathematics, the School of Natural Sciences, and the School of Social Science. Each School has a small permanent Faculty, and some 160 fellowships are awarded annually to Visiting Members from other research institutions and universities throughout the world.

The objectives of the Institute were described as follows in the Founders' original letter to the first Trustees: "The primary purpose is the pursuit of advanced learning and exploration in fields of pure science and high scholarship to the utmost degree that the facilities of the institution and the ability of the faculty and students will permit."

Though none of the Visiting Members are students in the narrow sense of being degree candidates, educational growth is still before them. The Institute devotes special attention to identifying young people of accomplishment and promise, and offers them membership at a stage in their careers when independent work is of the highest importance to their intellectual development.

Basis of Presentation

The accompanying financial statements are prepared on the accrual basis and are presented in accordance with recommendations contained in *Audits of Certain Nonprofit Organizations* by the American Institute of Certified Public Accountants. Certain minor reclassifications of previously reported 1985 amounts have been made to conform to 1986 account classifications.

Plant Assets and Depreciation

Uses of operating funds for plant acquisitions and principal debt service payments are accounted for as transfers to plant funds. Proceeds from the sale of plant assets, if unrestricted, are transferred to operating funds, or, if restricted, to deferred amounts restricted for plant acquisitions. Depreciation is provided over the estimated useful lives of the respective assets on a straight-line basis (buildings and capital improvements 20-40 years, equipment 3-6 years).

Fund Accounting

The accounts of the Institute are maintained in accordance with the principles of "fund accounting." This is the procedure by which resources for various purposes are

classified for accounting and reporting purposes into funds that are in accordance with activities or objectives specified. Separate accounts are maintained for each fund; however, in the accompanying financial statements, funds that have similar characteristics have been combined into fund groups.

Fund balances restricted by outside sources are so indicated and are distinguished from unrestricted funds allocated to specific purposes by action of the governing board. Externally restricted funds may only be utilized in accordance with the purpose established by the source of such funds and are in contrast with unrestricted funds over which the governing board retains full control to use in achieving any of its institutional purposes.

Endowment funds are subject to the restrictions of gift instruments requiring in perpetuity that the principal be invested and the income only be utilized. Quasi-endowment funds have been established by the governing board to function as endowment funds and any portion of these funds may be expended. Unrestricted funds functioning as endowments have no external restrictions. However, certain of these funds have been internally designated to support specific needs of the Institute.

All gains and losses arising from the sale, collection, or other disposition of investments and other non-cash assets are accounted for in the fund which owned such assets. Ordinary income derived from investments, receivables, and the like, is accounted for in the fund owning such assets, except for income derived from investments of endowment and similar funds, which income, if unrestricted, is accounted for as revenue in unrestricted operating funds, or if restricted, as deferred restricted revenue until used in accordance with the terms of the restriction or transferred to endowment and similar funds.

B. Investments

Investments purchased by the Institute are recorded at cost; investments received by gift are carried at fair market value at the date of donation. Realized gains and losses are computed based on the average cost of the investment.

Assets of endowment and similar funds are pooled with each individual fund subscribing to or disposing of units on the basis of the market value per unit, determined on a quarterly basis.

The following tabulation summarizes changes in relationships between carrying and market values of the pooled investments:

	Pooled Assets			Market Value Per Unit
	Market Value	Carrying Value	Net Increase	
July 1, 1985	\$136,964,906	\$122,192,607	\$14,772,299	\$5,339
June 30, 1986	165,242,290	139,284,958	25,957,332	6,460
Unrealized appreciation for the year ended June 30, 1986				
			11,185,033	

	Pooled Assets	Market Value	Carrying Value	Net Increase	Market Value Per Unit
Realized net gain for the year ended June 30, 1986				<u>17,603,604</u>	
Net change for the year ended June 30, 1986					<u>\$28,788,637</u>

Earnings per unit, for the year ended June 30, 1986, exclusive of realized gains and losses, amounted to \$316, after deducting management fees.

The pooled investments at June 30, 1986 are comprised of the following:

	Carrying Value	Market Value
Cash equivalents	\$ 5,750,792	\$ 5,750,792
Equity securities	82,625,405	105,131,523
Debt securities	48,161,401	51,612,615
Mortgages and notes receivable	2,224,585	2,224,585
Investment accounts receivable	2,882,006	2,882,006
Investment accounts payable	(2,359,231)	(2,359,231)
	<u>\$139,284,958</u>	<u>\$165,242,290</u>

C. Physical Plant

Physical plant and equipment are stated at cost at date of acquisition, less accumulated depreciation. Library books, other than rare books purchased subsequent to June 30, 1947, have not been capitalized because it is not practicable to determine the value of such books.

A summary of plant assets follows:

Land	\$ 1,834,557
Buildings and improvements	20,327,529
Equipment	4,759,050
Library books	199,508
Total	27,120,644
Less accumulated depreciation	(11,222,044)
Net book value	<u>\$15,898,600</u>

D. Long-Term Debt

A summary of long-term debt follows:

2.75%, 1956—Apartment Bonds	\$ 461,000
7.804%, 1980—NJEFA	8,250,000
Total	8,711,000
Less unamortized debt discount	(94,456)
Total long-term debt	<u>\$8,616,544</u>

On July 24, 1980, the Institute for Advanced Study received proceeds of the New Jersey Educational Facilities Authority (NJEFA) offer of \$8,775,000 Revenue Bonds, 1980 Series A, the Institute for Advanced Study Issue. Of the net proceeds, \$4,100,000 was used to reimburse the Institute for the construction of its West Building, Dining Hall, and Social Science Library, and \$1,976,559 was used to reimburse certain capital improvements. The balance was used for major repairs and remodeling to the apartment housing facility for Visiting Members and other construction and major remodeling projects of Institute facilities.

The bonds are dated July 1, 1980, bear interest payable semi-annually at the net average annual rate of 7.804%.

are subject to redemption at various prices, and require principal payments and sinking fund installments through July 1, 2011. Bond principal in the amount of \$120,000 matured on July 1, 1986 and bond principal in the amount of \$130,000 (1987), \$135,000 (1988), \$145,000 (1989), and \$155,000 (1990) will mature on July 1 of the designated years. The obligation to pay the Authority on a periodic basis, in the amounts sufficient to cover principal and interest due on the bonds, is a general obligation of the Institute and is collateralized by United States Treasury Notes, 13.00% due November 15, 1990, with an aggregate face amount of \$8,700,000.

The Institute for Advanced Study Apartment Bonds of 1956 are collateralized by (1) a first mortgage on the Members' housing project with a cost of \$2,193,299, (2) a first lien and pledge of gross revenues from the project and (3) United States Treasury Notes, 12.625% due November 15, 1987, with an aggregate face amount of \$125,000.

The apartment bonds, which mature serially on December 1 of each year, bear interest at the rate of 2.75% and require principal payments of \$36,000 in 1986, increasing each December 1 with final payment of \$48,000 due December 1, 1996, and are subject to redemption at various prices.

The interest expense for the year ended June 30, 1986 was \$664,000.

E. Retirement Plans

Separate voluntary defined contribution retirement plans are in effect for faculty members and eligible staff personnel, both of which provide for annuities which are funded with the Teachers Insurance and Annuity Association and/or the College Retirement Equities Fund. Payments for the year ended June 30, 1986 amounted to \$493,000.

In addition to the formal plans, the Board of Trustees or the Director has at various times authorized the payment of pensions to certain members, employees, and the widow of a deceased member. Total pension payments which aggregated \$82,000 for the year ended June 30, 1986 have been charged to expense and no reserves have been provided for pensions payable in subsequent years.

In addition to providing pension benefits, the Institute provides certain health care and life insurance benefits for retired employees and faculty. Substantially all of the Institute's employees may become eligible for those benefits if they reach normal retirement age while working for the Institute. The cost of retiree health care and life insurance benefits is recognized as expense as premiums are paid. For fiscal year 1986, those costs totaled \$49,000.

F. Funds Held in Trust by Others

The Institute is the residuary beneficiary of a trust under the Will of George Placzek, Deceased, and upon the death of the life tenant will be entitled to receive the corpus thereof. The approximate market value of the assets under the Will, as reported by the administrator of the Estate, aggregated \$1,685,000 as of June 30, 1986 and is not included in the accompanying financial statements.

G. Changes in Deferred Restricted Revenue

Restricted receipts, which are recorded initially as deferred restricted revenue, are reported as revenues when expended in accordance with the terms of the restriction. Changes in deferred restricted revenue amounts are as follows:

	TOTAL DEFERRED RESTRICTED REVENUE
Balance at July 1, 1985	<u>\$ 540,627</u>
Additions:	
Contributions, grants, etc.	2,661,388
Net restricted endowment income	<u>2,446,097</u>
Total additions	<u>5,107,485</u>
Deductions:	
Funds expended from contributions, grants, etc.	2,598,448
Funds expended from restricted endowment	1,606,082
Transfer to endowment and similar funds	<u>840,015</u>
Total deductions	<u>5,044,545</u>
Balance at June 30, 1986	<u><u>\$ 603,567</u></u>

H. Functional Allocation of Expenses

The costs of providing the various programs and other activities have been summarized on a functional basis in the statement of support and revenue, expenses, capital additions, and changes in fund balances. Accordingly, certain costs have been allocated among the programs and supporting services benefited. The costs incurred by the Institute in operating both the Dining Hall (\$275,000 net of \$275,000 in revenues) and Members' Housing (\$529,000 net of \$723,000 in revenues) have been allocated among the programs and supporting services benefited.

I. Securities Lending

At June 30, 1986, securities with a market value of approximately \$10,900,000 were on loan to brokerage firms. The securities are returnable on demand and are collateralized primarily by cash, letters of credit, or U.S. Government or agency securities. The market value of the related collateral was approximately \$10,800,000.

The Institute continues to receive the interest and dividends on the loaned securities. Income from the investment of the collateral amounted to \$48,000 for fiscal 1986, net of fees and related expenses.

Donors

The Institute for Advanced Study gratefully acknowledges contributions of gifts and grants in the amount of \$3,652,624 received between July 1, 1985, and June 30, 1986. Space limitations prohibit listing all those who supported the Institute during

this period. Following are the names of individuals and organizations who made contributions of \$1,000 or more. To all of the contributors, the Institute expresses its deepest appreciation.

Individuals

Anonymous donors
John Akers
Edward L. Anderson, Jr.
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